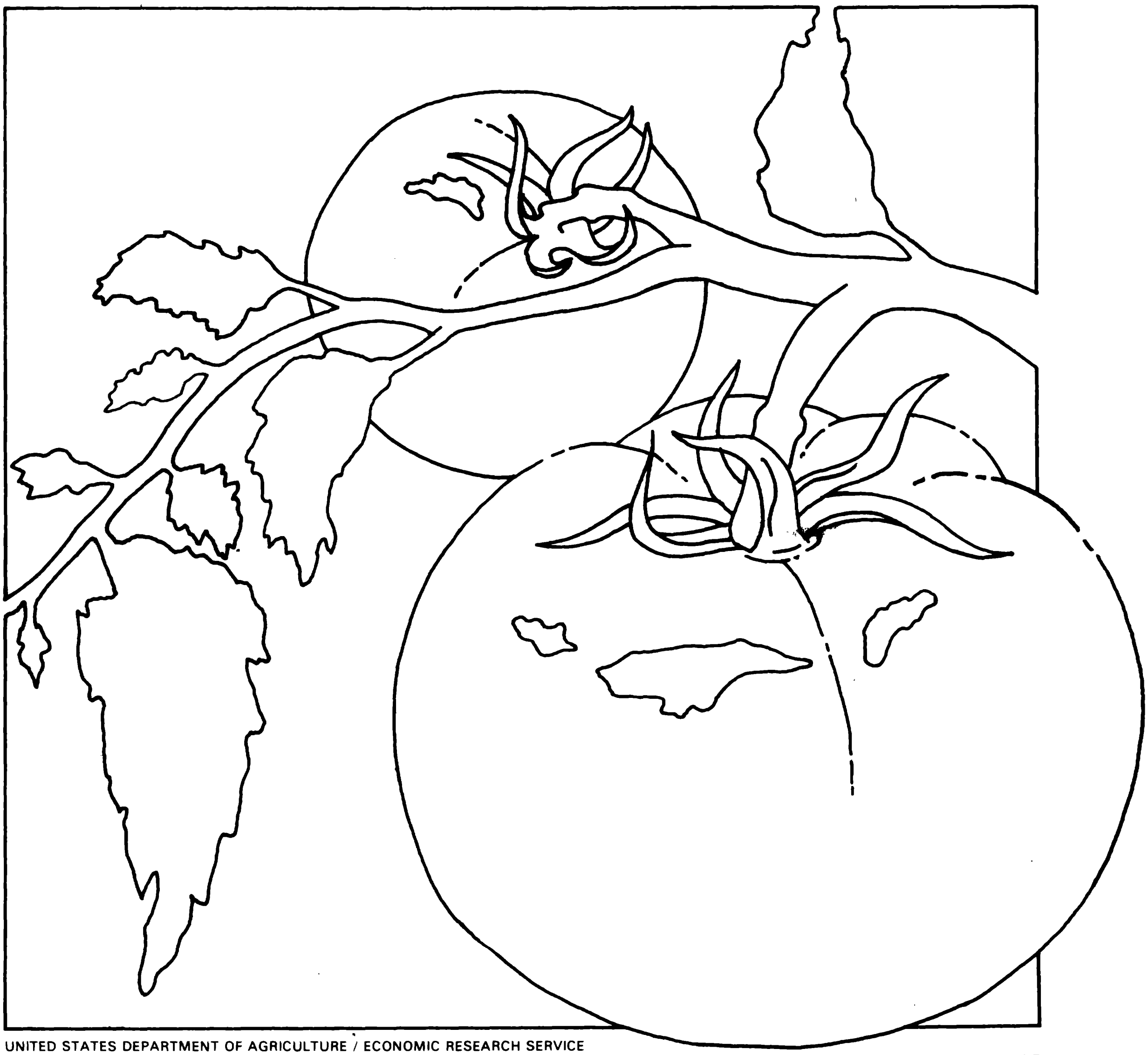
THE WINTER FRESH TOMATO INDUSTRY

A Systems Analysis



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ABSTRACT

Aggregate monetary and quantitative effects of supply-management policies on the fresh winter tomato industry participants were estimated. A computer simulation model was constructed with an interseasonal phase and an intraseasonal phase. It simulates the longrun effects of various supply-management policies that could be applied to tomatoes grown in Florida and tomatoes imported from Mexico in order to stabilize weekly f.o.b. prices at prespecified levels. The effects were higher, more stable retail prices and slightly smaller quantities consumed.

Keywords: Computer simulation model, consumers, Florida, Mexico, price stabilization, tomato.

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SUMMARY

Fresh tomatoes for the United States during the winter months are produced mostly in Florida and Mexico. Competition between the two production areas has been fairly intense since the late 1960's, and many court actions have followed concerning the legality of supply-management programs applied under authority of the Federal Marketing Order for Florida tomatoes. The controversy lies in the equity of the supply-management program as it affects handlers of imported tomatoes at the U.S. border, Florida producers and handlers, and domestic consumers. This study examines the aggregate effects of alternative supply controlling and marketing policies on these groups.

A computer simulation model of the U.S. winter fresh tomato industry was constructed with two major phases. The interseasonal phase uses an annual time period. The intraseasonal phase uses a weekly time period and could be considered the marketing phase. These phases were designed to evaluate the relative effects on subsector participants of stabilizing the weekly f.o.b. prices. The entire simulation model was then further divided by the two marketed types--mature green and vine-ripe tomatoes.

Simulation experiments were designed to evaluate the consequences of stabilizing f.o.b. prices at prespecified levels, using a mandatory import quota, and adjusting distribution between Florida and Mexico of the tomatoes restricted from the market. Since the model was not designed to optimize a particular variable, it was necessary to establish a base situation which has no supply restrictions and against which comparisons could be made from experiment results. The base situation was determined from many possibilities by selecting a particular set of projected exogenous variables.

Results of these simulation experiments show that a marketing policy of setting the f.o.b. price goal at 75 percent of parity would require only slightly higher expenditures by domestic consumers than those projected by the base situation. But consumers would be adversely affected if prices were set at 100 percent of parity.

Domestic producers would be favorably treated by implementing the marketing policy to stabilize f.o.b. prices at either 100 or 75 percent of parity. The domestic handlers of tomatoes would seem to be relatively satisfied with any of the projected volumes of Florida tomatoes given in the simulation experiments.

The handlers of imported Mexican tomatoes at the U.S. border would probably be distressed whenever a marketing order regulation was applied to restrict supply by reducing the volume imported from Mexico. They would also be adversely affected by an import quota; but the import quota, as specified in this study, would be less detrimental to these handlers than the marketing order program.

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by

John R. Brooker and James L. Pearson 1/

INTRODUCTION

Producing winter fresh tomatoes for U.S. markets has been the leading commercial vegetable enterprise in Florida for many years. Florida enjoys a weather advantage over other States and is the major domestic supplier of fresh tomatoes during the winter season (24, pp. 193-194). 2/ During the late fall and early spring seasons, Florida faces some competition from Texas and California. But during the winter season, the major competitors are exporters to the U.S. market, primarily Mexico.

Florida tomato production peaked in 1965/66 when slightly more than 18.9 million 40-pound cartons were sold in the fresh market. The highest dollar season of the decade was 1967/68 when less than 18 million crates were sold in the fresh market for almost $90 million (8). In the next two seasons, substantial downward trends occurred in production volume and in gross returns. Florida's tomato industry recovered, and in 1971/72 it shipped approximately 17 million 40-pound cartons for a value of about $102 million, an alltime high (8).

The decline in Florida production during 1967/68 through 1969/70 was apparently the direct result of increasing fresh tomato imports from western Mexico. Mexico has exported tomatoes and other vegetables to U.S. markets for decades, but only in the last few years have these exports penetrated the market extensively. From 1960/61 through 1964/65, Mexico supplied 22 to 24 percent of the total U.S. fresh tomato supply during the winter season (26). Thereafter, exports continually increased, with their share of the U.S. supply reaching an alltime high of 54 percent in 1969/70.

Winter, as used in this study, refers to the 7-month period beginning in November and ending in May. This period encompasses the late fall, winter, and early spring seasons (24). Texas is the only other domestic producer during the late fall period. Texas and California produce tomatoes for the fresh market in the early spring. Florida produces about 90 percent of the total domestic supply during this period.

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2/ Underscored numbers in parentheses refer to literature citations listed at the end of the report.

Competitive Positions

Except for labor, production inputs have generally been favorably priced for Florida tomato producers. Transportation has been a sizable expense to Mexican producers. The cost of simply transporting the fruit from Mexican packinghouses to Nogales, Ariz., for sale on the f.o.b. 3/ market averaged $0.84 per 20-pound carton in 1970/71 (7, p. 18).

Inputs such as tractors, fertilizer, packinghouse equipment, and cardboard cartons are all more expensive in Mexico than in Florida. Many of these items must be imported from the United States by Mexican producers.

Florida's competitive position is also enhanced by the U.S. tariff on imported tomatoes. One study of the impact from changing tariffs on winter tomatoes shows that the tariff has a considerable effect on the distribution of production between Florida and Mexico. It was estimated that if the tariff were set at zero, it would have cost Florida producers $25.9 million in 1967 (6, p. 128).

Weather gives Mexico the long-term advantage over Florida, but the in-season week-to-week advantage belongs to Florida because of lower marketing costs (7, p. 5). If Florida producers continue to retain their in-season advantage, they are likely to maintain their share of the U.S. market, and perhaps increase it when a mechanical harvester is fully adopted.

The economic viability of the Florida tomato industry appears to depend on its power to retain its competitive position by using tariffs, marketing orders, and possibly import quotas. This study analyzes these last two institutional factors.

Objectives and Procedures

This study examines the effects of alternative marketing policies on selected segments of the U.S. winter fresh tomato sector. These effects were measured in terms of (1) the total net revenue obtained by the Florida tomato growers; (2) the total volume of tomatoes shipped from Florida and Mexico to secondary handlers in the United States, which served as a proxy for the volume purchased by consumers; and (3) retail prices, which were estimated from the average f.o.b. price.

Florida's Tomato Committee administers the marketing programs permitted under a Federal Marketing Order. In the past it has been forced to make decisions with less than adequate information about the economic variables affecting tomatoes and their interrelationships. This study provides information to help the Florida tomato industry make marketing decisions. This information may also be useful to consumers, growers, handlers, and public agencies concerned with the industry, and to other commodity groups faced with similar circumstances. It can help the Secretary of Agriculture in evaluating marketing recommendations from the Florida Tomato Committee.

3/ The term f.o.b. means free on board; the f.o.b. price is the return per unit at shipping point including packing and selling fees.

Three objectives will be developed to provide the information and to evaluate the economic impact of changes in Mexican imports and in the Florida Tomato Committee's marketing policy. These objectives are to (1) qualitatively describe the physical, informational, and monetary flows within the U.S. winter fresh tomato sector; (2) define the structural relationships of the sector; and (3) develop a computer simulation model from the results of 1 and 2.

SUPPLY-MANAGEMENT TECHNIQUES

Supply-management strategy centers around the controlling or restricting of tomato shipments in order to stabilize prices at the desired level. The Florida tomato industry has two possible methods of controlling the importation of tomatoes from Mexico and the shipments from Florida. The first method, which is currently legal and operative, is a Federal Marketing Order. This order has been the focal point of the supply-management programs rather than the long-used tariff. The second method is to control supplies from Mexico by using a mandatory import quota such as the one introduced in Congress but never enacted into law (9).

By using a Federal Marketing Order, the Florida tomato industry can impose restrictions on tomato shipments by grade, size, and maturity in an effort to stabilize f.o.b. prices. The supply-management strategies explored in this study center on the use of size and maturity as a means of grouping restricted and nonrestricted tomatoes. Florida separates its tomatoes into 84 grade, size, and maturity categories. For this study, the categories were reduced to a more reasonable number for analysis. 4/ By delineating only sizes and maturity, this was partly accomplished. Grades were eliminated by computing a weighted average price for tomatoes by size and maturity. Sizes were also grouped together so that only two categories of the original seven remained.

Marketing Policy

Marketing policy, or more specifically the supply-management policy, refers to the course of action followed by the Florida tomato industry to stabilize the f.o.b. price for fresh market tomatoes at a specified level. This is the basic consideration in developing the simulation model.

Two possible supply-management policies for the Florida tomato industry are examined in this study. Each policy is interpreted in an effort to determine the economic effects on the various participants in the industry. One policy is to obtain 75 percent of the parity price for tomatoes at the f.o.b. level, and the other is to obtain 100 percent. 5/ The basic supply-management strategy was to stabilize prices at the desired f.o.b. level by determining the needed amount of supply restriction between Florida and Mexico.

4/ Fresh market tomatoes are placed in six grades--U.S. No. 1, 85 percent U.S. No. 1, combination, U.S. No. 2, U.S. No. 3, and ungraded. Tomatoes are also placed in seven size categories--4x5, 5x5, 5x6, 6x6, 6x7, 7x7, and 7x8.

5/ Parity price, as used in this study, is defined by USDA and determined for all tomatoes on a monthly basis (23).

Producers in Mexico and Florida dispute the use of dual regulations under the marketing order. But dual size regulations have been imposed under the marketing order for only two seasons, 1968/69 and 1969/70. Producers can ship a larger size of mature green tomato than they can of a vine-ripe tomato. Florida produces mostly mature green tomatoes and Mexico mostly vine-ripe tomatoes. The rationale for the dual regulation is to provide equal treatment to growers of both types, because the size distributions are not the same when these types are produced. Without a dual size regulation, nearly all of a supply-restricting action would occur in Florida (11). Under the regulations, Mexican producers can still sell their smaller sized tomatoes in Mexico and Canada where the regulations do not apply.

Two assumptions regarding supply restrictions can be examined in separate simulation experiments. The first assumption is that all of the supply restrictions that are necessary to stabilize prices at the desired f.o.b. price level occur proportionately in Florida and Mexico. The alternate assumption is that the supply restrictions occur only in Florida.

Other features considered under basic supply-management policies deal with the supply of imported tomatoes from Mexico. Two alternatives are examined. The first is a mandatory weekly import quota on Mexican tomatoes under regulations similar to those specified in H.R. 14624 (9). The other alternative is statistically estimating the supply of tomatoes from Mexico.

In summary, this study considers two basic marketing policies. It covers two assumptions concerning size regulations for influencing the distribution of restricted supplies between Florida and Mexico and two alternatives for determining the supply of tomatoes available from Mexico. Assumptions for a base simulation model of the tomato industry and for four alternative experiments are shown in table 1.

Marketing Orders

The marketing order program authorized by the Agricultural Marketing Agreement Act of 1937, is a frequent tool of agricultural groups to solve marketing problems. The broad objective of agreements and orders is an orderly marketing of tomatoes to increase returns for producers. Throughout this study, the administering agent of the marketing order is termed the Florida Tomato Committee.

The four basic regulating restrictions allow the Florida Marketing Order for tomatoes to:

1. limit the handling of all varieties of tomatoes from the production area by grade, size, and maturity;

2. limit the handling of particular grades, sizes, quantities or packs of tomatoes differently for different varieties, stages of maturity, portions of the production area, containers, markets, and any combination of the above;

3. limit the handling of tomatoes by establishing minimum standards of quality and maturity in terms of grades and sizes; and

Table 1--Assumptions used for a base simulation model of the tomato industry and four experiments

Specifications and assumptions for--	Base model	Experiment I A	Experiment I B	Experiment II A	Experiment II B	Experiment III A	Experiment III B	Experiment IV
Market policy that promotes--								
1. Free market 1/	X							X
2. Supply-management to achieve 100 percent of parity price		X		X		X		
3. Supply-management to achieve 75 percent of parity price			X		X		X	
Mexican supply that is--								
1. Unrestricted	X	X	X					
2. Restricted to certain sizes 2/				X	X			
3. Determined by mandatory import quota						X	X	X
Florida supply that is--								
1. Unrestricted	X							X
2. Restricted to certain sizes 2/		X	X	X	X	X	X	

1/ Quantity control regulations as part of Federal Marketing Order program are not imposed.
2/ This is an assumption concerning tomatoes removed from the market because of a Federal Marketing Order that restricts shipments.

4. specify the containers that may be used to handle tomatoes by specifying the size, weight, capacity, dimensions, labels, and pack (21, p. 164).

Section 8e of the Agricultural Marketing Agreement Act of 1937 is the tool that makes the order useful to the Florida tomato industry (25, p. 20). This section requires the same standards of grade, size, quality, and maturity for imported tomatoes and for the domestic tomatoes that are under the Federal Marketing Order. This section was enacted on August 28, 1954. The domestic area regulated by the Federal Marketing Order is comprised of 23 south Florida counties. The order does not directly affect those counties in north Florida that produce a small quantity of early summer tomatoes nor any other domestic suppliers during the November through May winter season (14, 20).

The importers organized the West Mexico Vegetable Importers Association. Their interests are not entirely compatible with those of Mexican producers. This point was researched by Juan Montes (16) in a study which shows that Mexican producers benefit from the regulations of a marketing order as equally as would the Florida producers.

One vital characteristic of a successful marketing order is that it can control nearly all of the tomatoes produced during a given time period. A State marketing order, which would not affect Mexican shipments, would not be completely satisfactory to domestic producer interests. The supply is restricted and the price raised for a short period, so available supply must be controlled by the marketing order. Exceptions to the control of the Federal Marketing Order for Florida include hothouse tomatoes, hydroponic tomatoes, cherry tomatoes, and other domestically produced tomatoes outside the 23 counties in South Florida.

STRUCTURAL MODEL OF TOMATO SUBSECTOR

The period from November through May is defined as the winter season or year in this study. During winter more than 90 percent of the fresh market tomato supply in the United States is produced by Florida and Mexico.

Parallel production and marketing stages for vine-ripe and mature green tomatoes were specified in both production areas. The two types were also assumed to be distinguishable at the consumer retail outlets. Traditionally, a large share of the mature green tomatoes were sold at retail outlets in tubes and other prepackaged containers because storage and repacking were necessary at northern cities. Vine-ripe tomatoes are generally sold loose in bulk bin displays (4). But apparently many consumers do not know which type of tomato they are buying, because ethylene gas is often used to hasten and control the uniform ripening of mature green tomatoes. Today, these "gassed" tomatoes do not need to be rehandled by a repacker; consequently, they reach the retail outlet in bulk cartons and may be displayed in the same manner as vine-ripe tomatoes. In this study, mature green tomatoes from Mexico were treated as perfect substitutes for those from Florida.

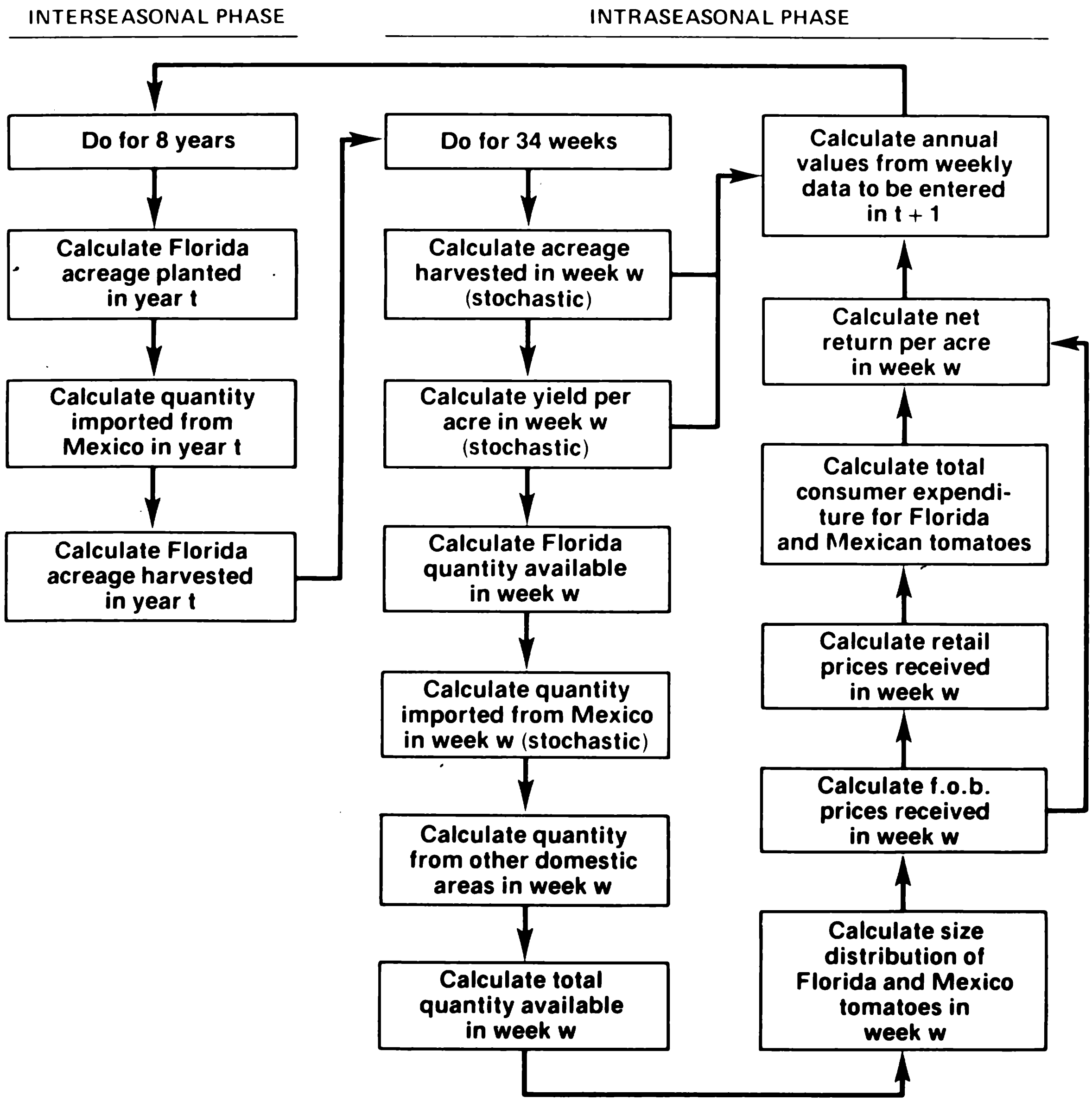

Figure 1--Flow chart of major parts of simulation model

Flow Chart

The major components of the simulation model are shown in figure 1. 6/ The interseasonal phase is based on a period of 1 year. This phase can determine the expected supply from Mexico in year t and the expected acreage of the Florida harvest in year t. During the intraseasonal or within-season phase, the model is based on a period of 1 week. This phase can stabilize f.o.b. prices at a given level by reducing the quantity shipped to U.S. markets from Florida or Mexico or both, whenever the f.o.b. price falls below that level. By separating the simulation model into phases, the longrun and shortrun conditions can be shown.

6/ For a more detailed representation of the industry, see Brooker (3).

Interseasonal Phase

Initially, the interseasonal phase of the model is concerned with the total supply of tomatoes to be sold in the United States during the winter season. The Florida acreage planted in mature green and vine-ripe tomatoes is estimated in equations 1 and 2. Next, the quantity of tomatoes imported from Mexico is estimated for both kinds of tomatoes in equations 3 and 4. Equations 5 and 6 in the interseasonal phase estimate the Florida tomato acreage harvested each year.

Planted Acreage

The equations were developed to estimate the Florida acreage planted to vine-ripe and mature green tomatoes. It was hypothesized that the acreage of tomatoes planted in the current year was mainly dependent on the amount of acreage harvested in the previous year, on the net returns per acre for the previous year, and on the total quantity of tomatoes imported from Mexico in the previous year.

Most of the structures were estimated by ordinary least squares (OLS) since the entire model is made up of single equation relationships. For each equation the standard errors of coefficients are shown in parenthesis beneath the coefficient.

EQUATION 1

$$PAFMG_t = 9.168 + \underset{\substack{(0.1622)\\ ***}}{0.88617}\ HAFMG_{t-1} + \underset{\substack{(0.01511)\\ **}}{0.04326}\ NRFMG_{t-1} - \underset{(1.434)}{3.0863}\ CITOM_{t-1}$$

$R^2 = .83$ df = 14 D-W = 1.79

EQUATION 2

$$PAFVR_t = 1.273 + \underset{\substack{(0.1970)\\ ***}}{0.87164}\ HAFVR_{t-1} + \underset{(0.0779)}{0.001157}\ NRFVR_{t-1} - \underset{(0.6797)}{0.28916}\ CITOM_{t-1}$$

$R^2 = .76$ df - 12 D-W = 1.67

where

$PAFMG_t$ = planted acreage of Florida mature green tomatoes in year t

$PAFVR_t$ = planted acreage of Florida vine-ripe tomatoes in year t

$HAFMG_{t-1}$ = harvested acreage of Florida mature green tomatoes in year t-1

$HAFVR_{t-1}$ = harvested acreage of Florida vine-ripe tomatoes in year t-1

$NRFMG_{t-1}$ = net returns per acre for Florida mature green tomatoes in year t-1

$NRFVR_{t-1}$ = net returns per acre for Florida vine-ripe tomatoes in year t-1

$CITOM_{t-1}$ = per capita disappearance of imported mature green and vine-ripe tomatoes in year t-1

t = year

R^2 = coefficient of determination

df = degrees of freedom

D-W = Durbin-Watson statistic

* = significant at 0.10 level

** = significant at 0.05 level

*** = significant at 0.01 level

Quantity Imported

Severe limitations on data from Mexico precluded any attempt to determine Mexican supply in the same manner as it was for Florida. Historical data or even current data for planted acreage, f.o.b. prices, and net returns in Mexico were not available. Information was available on the total quantity of tomatoes imported by the United States from Mexico, although total Mexican production was not known. This import information was used to develop single-equation supply functions for vine-ripe and mature green tomatoes from Mexico.

A basic hypothesis was made for the functional relationships to estimate the supply of tomatoes from Mexico. The quantity to be imported in the current year was a function of the quantity of both kinds of tomatoes imported in the previous year, of the average f.o.b. price of tomatoes in Florida the previous year, and of a qualitative variable representing the Federal Marketing Order for Florida tomatoes.

EQUATION 3

$$CIMG_t = \underset{(0.08247)}{\underset{*}{-\ 0.14276}}\ CIVR_{t-1} + \underset{(0.0652)}{\underset{***}{0.2404}}\ MKTORD_t$$

$$+ \underset{(0.327833)}{0.69645}\ CIMG_{t-1} + \underset{(0.03479)}{0.02115}\ PMG_{t-1}$$

$R^2 = .74$ df = 17 D-W - 2.02 p = 0.2

EQUATION 4

$$CIVR_t = \underset{(0.272492)}{\underset{**}{0.730033}}\ CIMG_{t-1} - \underset{(0.134465)}{\underset{**}{0.350312}}\ MKTORD_t$$

$$+ \underset{(0.0258253)}{\underset{***}{0.0840456}}\ PVR_{t-1} + \underset{(0.142505)}{\underset{***}{0.648083}}\ CIVR_{t-1}$$

$R^2 = .97$ df = 10 D-W = 1.95 p = -0.1

where

$CIMG_t$ = per capita disappearance of imported mature green tomatoes in year t

$CIVR_t$ = per capita disappearance of imported vine-ripe tomatoes in year t

PMG_t = average annual f.o.b. price of mature green tomatoes in Florida

PVR_t = average annual f.o.b. price of vine-ripe tomatoes in Florida

$MKTORD_t$ = qualitative variable to represent the Federal Marketing Order for Florida tomatoes; equals 1 during years when the order was active, otherwise it equals 0

p = autocorrelation coefficient

The average annual f.o.b. price of tomatoes in Florida was used as a proxy variable for the f.o.b. price of tomatoes in Mexico. This assumes that prices in the two markets are determined under competitive conditions. Except for location, the variable that most affects the price differential between Florida and Mexico is probably quality. But quality is a variable that is not directly observable since size and grade do not account for many nonvisible characteristics of quality.

Acreage Harvested

After the planted acreage in Florida had been estimated in equations 1 and 2, the next stage in the recursive system for estimating the annual Florida supply was to calculate the acreage harvested. The acreage harvested each year and the acreage planted are of course closely related. Other variables hypothesized as having a significant effect on the acreage harvested were the quantity of tomatoes imported from Mexico and the Federal Marketing Order, a qualitative variable.

EQUATION 5

$$HAFMG_t = 7.854 + \underset{\substack{(0.1183)\\ ***}}{0.79054}\ PAFMG_t - \underset{(1.583)}{0.32355}\ MKTORD_t - \underset{(1.076)}{0.69339}\ CITOM_t$$

$R^2 = .92$ df = 14 D-W - 1.51

EQUATION 6

$$HAFVR_t = -0.01787 + \underset{\substack{(0.02754)\\ ***}}{0.87351}\ PAFVR_t - \underset{(0.1206)}{0.1349}\ MKTORD_t + \underset{\substack{(0.1055)\\ **}}{0.24584}\ CITOM_t$$

$R^2 = .99$ df - 12 D-W = 2.30

where

$HAFMG_t$ = acreage harvested in Florida as mature green tomatoes in year t

$HAFVR_t$ = acreage harvested in Florida as vine-ripe tomatoes in year t

$PAFMG_t$ = acreage planted in Florida as mature green tomatoes in year t

$PAFVR_t$ = acreage planted in Florida as vine-ripe tomatoes in year t

$MKTORD_t$ = qualitative variable representing the Federal Marketing Order for Florida tomatoes

$CITOM_t$ = per capita disappearance of imported tomatoes in year t

At this point, the relationships determining the total quantity of tomatoes to be imported from Mexico and the total acreage to be harvested in Florida were known. Therefore, these equations provided input data for the intraseasonal phase of the model.

Intraseasonal Phase

The supply of fresh tomatoes is fixed at any given time during the marketing season (intraseasonal phase). Such a perishable commodity cannot be stored for more than a few days. Assuming the shortrun demand remains unchanged, prices fluctuate widely as the market supply shifts from week to week during the season. This is shown by the rapid price changes for tomatoes at the f.o.b. price, because the price per carton may change $2 or $3 from one week to the next. For any given week of the harvesting season, it was assumed that the week's derived supply was highly inflexible and would be sold at whatever price could be obtained or the supply was abandoned at the packinghouse.

During the intraseasonal phase, the model is on a weekly time basis. This stabilizes f.o.b. prices at the specified level. Figure 1 shows this by calculating the quantity available each week and then the resulting f.o.b. price. If the f.o.b. price is below the desired price level, then shipping restrictions are imposed on the smaller tomato sizes and lower grades.

An essential part of the intraseasonal phase was estimating the weekly f.o.b. prices. Variation in the weekly estimated prices because of changes in supply was considered important since supply affects actual prices. To create the needed variation in weekly prices several stochastic, or random, elements were incorporated in this phase of the model, reflecting the influence of weather and other noneconomic factors. These stochastic features were added to the calculation of the weekly harvested acreage in Florida, yield per acre in Florida, and quantity imported from Mexico. 7/

Acreage Harvested Weekly

The sequence of steps in the intraseasonal phase is quite similar to that of the interseasonal phase. The total weekly supply was estimated in a stepwise recursive system. First, the supply in Florida for week "w" was determined from a recursive system composed of two parallel sets of three equations--one set for mature green tomatoes and the other for vine-ripe tomatoes. Second, the supply from Mexico in week "w" was determined and combined with Florida's supply to obtain the total volume of fresh tomatoes placed on the market from Florida and Mexico.

7/ For each of these stages in the intraseasonal phase, a subroutine was used to generate a random number from a normal distribution. The distribution was defined as having a zero mean and 1.0 standard deviation. This permitted the random selection of a standard normal variate that ranged from -3 to +3 for 99 percent of the selections. The randomly selected value was then multiplied by the standard deviation of the appropriate variable to derive the needed coefficient. The use of this coefficient is explained when each component of this phase of the model is discussed.

Equations in this phase were designed to calculate the Florida acreage harvested each week. The distribution of acreage harvested during the season was assumed to follow a fairly consistent pattern year after year.

EQUATION 7

$$HAFMG_w = (HAFMG_t) \quad (\lambda FMG_w) + (TX_w) \quad (SDMG_w)$$

EQUATION 8

$$HAFVR_w = (HAFVR_t) \quad (\lambda FVR_w) + (TX_w)$$

where

$HAFMG_w$ = acreage of Florida mature green tomatoes harvested in week w

$HAFVR_w$ = acreage of Florida vine-ripe tomatoes harvested in week w

λFMG_w = percentage of total annual shipments of mature green tomatoes from Florida in week w, average of previous 9 years

λFVR_w = percentage of total annual shipments of vine-ripe tomatoes from Florida in week w, average of previous 9 years

$SDMG_w$ = standard deviation of acreage harvested each week of mature green tomatoes

$SDVR_w$ = standard deviation of acreage harvested each week of vine-ripe tomatoes

TX_w = randomly selected standard normal variate in week w

Information was not available to estimate the acreage harvested from a functional relationship. So, a weather variable was indirectly included in the model by using a stochastic derivation of yield per acre.

Yield Per Acre

The yield per acre during a marketing season varies considerably. The weekly yield was randomly determined to make this stage of the model more realistic. Deviations in yield from the average yield were assumed to be represented by a normal distribution.

Yield per acre is affected by both economic and noneconomic factors. Weather is a strategic noneconomic factor and one that was not directly included in this analysis. The difference between actual yield and quantity sold is that part of the crop lost because of economic abandonment. In other words, when the price falls to the level where variable or direct costs of harvesting are not covered, the crop is abandoned. This does not necessarily mean the entire field is abandoned since the field may have already been "picked" one or more times.

It was hypothesized that the expected yield per acre in Florida is based on the yields obtained in previous years. The average yield over the previous 5 years was considered the expected yield for the current year in this stage of the model, since a trend was not revealed.

In equations 9 and 10, the randomly selected value, TW, was multiplied by the standard deviation of the mature green and vine-ripe tomato yield over the past 5 years. This provides deviations from the mean yield for crop maturity in each week of the season.

EQUATION 9

$$YFMG_w = YFMG_t + (TW_w) \quad (SDFMG_t)$$

EQUATION 10

$$YFVR_w = YFVR_t + (TW_w) \quad (SDFVR_t)$$

where

$YFMG_w$ = yield per acre of Florida mature green tomatoes in week w

$YFVR_w$ = yield per acre of Florida vine-ripe tomatoes in week w

TW_w = randomly selected standard normal variate in week w

$YFMG_t$ = average yield per acre for mature green tomatoes over the past 5 years

$FYVR_t$ = average yield per acre for vine-ripe tomatoes over the past 5 years

$SDFMG_t$ = standard deviation of Florida mature green tomato yields per acre over the past 5 years

$SDFVR_t$ = standard deviation of Florida vine-ripe tomato yields per acre over the past 5 years

Florida Quantity Harvested

Total Florida production of mature green and vine-ripe tomatoes for week w was estimated in equations 11 and 12 by multiplying yield per acre by the acreage harvested. The term production was used to represent the total quantity harvested and sold in week w, including quantities not harvested later because of a supply restriction. The distribution of the total quantity by size and grade was assumed to follow a fixed pattern and will be discussed later.

EQUATION 11

$$QFMG_w' = (HAFMG_w) \quad (YFMG_w)$$

EQUATION 12

$$QFVR_w = (HAFVR_w)\ (YFVR_w)$$

where

$QFMG_w$ = quantity of Florida mature green tomatoes harvested in week w

$QFVR_w$ = quantity of Florida vine-ripe tomatoes harvested in week w

Mexican Quantity Imported

The quantity of tomatoes imported each week from Mexico was determined by using equations 13 and 14. The acreage harvested each week in Florida was determined by a similar method. Based on the past few years, an average value was calculated for each week to represent the percentage of the total annual volume historically imported in week w. This technique was used when the total annual supply from Mexico for the year was estimated from the functional relationships of equations 3 and 4 or prespecified on the basis of an import quota.

EQUATION 13

$$CIMG_w = (CIMG_t)\ (\Omega IMG_w) + (TY_w)\ (SDIMG)$$

EQUATION 14

$$CIVR_w = (CIVR_t)\ (\Omega IVR_w) + (TY_w)\ (SDIVR)$$

where

$CIMG_w$ = per capita disappearance of mature green tomatoes imported from Mexico in week w

$CIVR_w$ = per capita disappearance of vine-ripe tomatoes imported from Mexico in week w

ΩIMG_w = percentage of total annual mature green tomatoes imported from Mexico in week w, average of previous 9 years

ΩIVR_w = percentage of total annual vine-ripe tomatoes imported from Mexico in week w, average of previous 9 years

$SDIMG_w$ = standard deviation of weekly imports of mature green tomatoes

$SDIVR_w$ = standard deviation of weekly imports of vine-ripe tomatoes

TY_w = randomly selected standard normal variate in week w

Quantity From Other Domestic Areas

During the middle of the winter season, most of the tomatoes sold in the United States come from Mexico and Florida, with a small amount supplied by hothouses. At the beginning of the winter season, some competition comes from California and at the end of the season, from Georgia and South Carolina. In equation 15 a third quantity variable was added to represent all domestic fresh tomato sources except for Florida.

EQUATION 15

$$COTOM_w = (\lambda OTOM_w) \quad (QOTOM_t) \div POP_w$$

where

$COTOM_w$ = per capita disappearance of tomatoes shipped from all domestic areas other than Florida in week w

$\lambda OTOM_w$ = percentage of total winter shipments from all domestic areas other than Florida shipped in week w, average of previous 9 years

$QOTOM_t$ = total quantity of tomatoes supplied from all domestic areas other than Florida in year t

POP_w = total U.S. population in week w

Although cherry tomatoes are an important substitute for mature green and vine-ripe tomatoes, they were excluded from this analysis because little, if any, information is available on historical prices and quantities. Florida produces very few cherry tomatoes since Mexico has captured most of this market; also cherry tomatoes are not covered under the Marketing Order.

Size Distribution

The f.o.b. price for tomatoes at the shipping point level was hypothesized to be primarily a function of the quantity available. In other words, the quantity available in any particular week of the season is predetermined and is placed on the market for the prevailing price.

The definition of tomato sizes used in this model is the same as the one imposed by the Florida tomato marketing order when the dual size regulation was in force. By this definition, large vine-ripe tomatoes are classified as 6x6 and larger, but large mature green tomatoes are classified as 6x7 and larger. The quantities of tomatoes obtained in equations 11, 12, 13, and 14 were placed in these two size categories.

The distribution of shipments between the various size and grade categories appeared to depend upon price as well as the available volume and physical characteristics of the tomatoes. When prices are considered high, generally all grade and size categories are sold and shipped (table 2). In this situation, prices are evidently high enough to cover the variable costs of marketing the lesser sizes and grades. But when prices are lower, the lesser grades and sizes are not shipped (table 3). Certainly this economic abandonment is caused by prices that are lower than the variable costs of marketing.

Table 2--Percentage of mature green and vine-ripe tomatoes shipped from Florida, by grade and size, during a week when high f.o.b. prices were received 1/

Grade of tomatoes	Shipped size of mature green tomatoes 2/					Shipped size of vine-ripe tomatoes 2/				
	6 x 6 and larger	6 x 7	7 x 7	7 x 8	Total	6 x 6 and larger	6 x 7	7 x 7	7 x 8	Total
	Percent									
U.S. #1	23.0	22.7	11.4	2.4	59.5	14.6	2.6	0.7	0.2	18.1
Combination	5.5	5.1	2.5	.2	13.3	22.5	6.8	2.1	.3	31.7
U.S. #2	6.2	5.9	3.3	.3	15.7	15.6	2.7	.7	3/	19.0
U.S. #3	3.2	3.0	.7	.1	7.0	16.1	3.6	1.3	.1	21.1
Ungraded	2.3	1.7	.5	3/	4.5	6.2	3.0	.8	.1	10.1
Total	40.2	38.4	18.4	3.0	100.0	75.0	18.7	5.6	.7	100.0

1/ Data is based on an unpublished survey conducted during winter of 1973. The survey recorded prices and quantities from sales invoices for the entire 1971/72 season of 15 packinghouses in Florida.
2/ Week ending on January 15, 1972.
3/ Less than 0.1 percent.

Table 3--Percentage of mature green and vine-ripe tomatoes shipped from Florida, by grade and size, during a week when low f.o.b. prices were received 1/

Grade of tomatoes	Shipped size of mature green tomatoes 2/					Shipped size of vine-ripe tomatoes 2/				
	6 x 6 and larger	6 x 7	7 x 7	7 x 8	Total	6 x 6 and larger	6 x 7	7 x 7	7 x 8	Total
	Percent									
U.S. #1	29.3	28.7	8.3	3/	66.3	39.0	3.8	0.9	0	43.7
Combination	5.2	1.1	.2	0.1	6.6	5.2	2.4	.1	0	7.7
U.S. #2	10.0	5.9	.6	0	16.5	10.6	.6	0	0	11.2
U.S. #3	8.0	2.6	3/	0	10.6	29.7	4.3	.4	0	34.4
Ungraded	0	0	0	0	0	2.6	.4	0	0	3.0
Total	52.5	38.3	9.1	0.1	100.0	87.1	11.5	1.4	0	100.0

1/ Data is based on an unpublished survey conducted during winter of 1973. The survey recorded prices and quantities from sales invoices for the entire 1971/72 season of 15 packinghouses in Florida.

2/ Week ending on December 26, 1971.

3/ Less than 0.1 percent.

As specified earlier, weekly supplies were considered to be highly inelastic. Weekly supplies become less inelastic when the price falls below the point that covers the variable costs of packing and shipping the lesser grades and sizes. Thus, the weekly supply curve has a positive upward slope until the average f.o.b. price reaches the point where marketing all sizes and grades is profitable. The supply curve then becomes perfectly inelastic.

Distributions of shipments by grade and size change between high and low price situations. This is one of the basic justifications for discriminating by size between mature green and vine-ripe tomatoes. By comparing tables 2 and 3 and moving from a high to a low price situation, the proportion of vine-ripe tomatoes in the 6x7 category drops from 18.7 to 11.5 percent. The proportions in the 7x7 and 7x8 categories also decrease as the price falls. On the other hand, the proportion of mature green tomato shipments remains almost the same in the 6x7 category and decreases in the 7x7 and 7x8 categories.

The major point is that the distribution of tomato shipments by grade and size varies with price. Use of the distribution associated with high prices did not appear logical, because a supply restricting regulation would certainly not be requested when prices are favorable. But the distribution associated with low prices can be used, because prices are not favorable and a supply restricting regulation would then be requested.

The equity of a supply restriction on growers and handlers is an issue of prime concern when evaluating the effects of using the Federal Marketing Order. If a supply regulation prohibits the shipment of small vine-ripe and mature green tomatoes, as defined earlier, then 9.2 percent of the mature green tomatoes are restricted and 12.9 percent of the vine-ripe tomatoes are restricted (table 3).

This issue is brought into sharper focus if the large vine-ripe tomatoes are defined on the same size basis as the mature green tomatoes, that is, 6x7 and larger. If the prices are low, only 1.4 percent of the vine-ripe tomato shipments are restricted compared to 9.2 percent of the mature green tomatoes. If the prices are high, then only 6.3 percent of the vine-ripe tomato shipments are restricted compared to 21.4 percent of the mature green tomatoes (table 2). This implies that unless the 6x7 sized vine-ripe tomatoes are included in the smaller category, the effect of a restriction on shipments of small mature green and vine-ripe tomatoes is quite inequitable for growers and handlers of mature green tomatoes.

Equations 16 and 17 represent the supply of small mature green and vine-ripe tomatoes from Florida. Their underlying hypothesis is that the quantity variables depend on the acreages harvested, on the quantity of all tomatoes shipped the previous week, and on the prices received in the previous week. Economic theory suggests that both the price variable and the acreage variable should have positive coefficients. Conversely, the quantity variable should have a negative coefficient, because it represents the volume of tomatoes in the "pipeline." The pipeline was defined as the marketing system between the shipping point and the retail or institutional market. This quantity variable was also tested by using a 2-week lag, but the lagged variable was not significant.

EQUATION 16

$$CFSMG_w = 1.172 + \underset{\substack{(0.03134)\\ *}}{0.05411}\ PSMG_{w-1} + \underset{\substack{(0.01016)\\ ***}}{0.046077}\ HAFMG_w$$

$$- \underset{\substack{(0.009897)\\ ***}}{0.049295}\ CTOM_{w-1}$$

$R^2 = .72$ df = 24 D-W = 1.73

EQUATION 17

$$CFSVR_w = 0.3028 + \underset{(0.00555)}{0.00105}\ PSVR_{w-1} + \underset{\substack{(0.04206)\\ ***}}{0.13025}\ HAFVR_w$$

$$- \underset{(0.00522)}{0.00756}\ CTOM_{w-1}$$

$R^2 = .65$ df = 24 D-W = 1.04

where

$CFSMG_w$ = per capita disappearance of small mature green tomatoes from Florida

$CFSVR_w$ = per capita disappearance of small vine-ripe tomatoes from Florida

$PSMG_{w-1}$ = average f.o.b. price of small mature green tomatoes in week w-1

$PSVR_{w-1}$ = average f.o.b. price of small vine-ripe tomatoes in week w-1

$CTOM_{w-1}$ = per capita disappearance of all tomatoes shipped during week w-1

$HAFMG_w$ = harvested acreage of Florida mature green tomatoes in week w

$HAFVR_w$ = harvested acreage of Florida vine-ripe tomatoes in week w

Imports of small mature green tomatoes from Mexico were negligible in the years that data are available. So it has been specified in this model that all of the mature green tomatoes imported from Mexico fall into the larger sized category. For this reason, a supply function for small mature green tomatoes from Mexico was not included in the system.

The shipments of vine-ripe tomatoes from Mexico show a definite pattern that can be associated with time. The proportion of the total weekly Mexican shipments that could be placed in the large sized category increased after several weeks of the season had passed. It remained fairly steady until it decreased in the last couple of months of the season. One explanation for this may be the actions taken by the Mexican producers union, Union Nacional de Productores de Hortalizas (UNPH), although seasonal factors have some effect on size distribution, too.

UNPH has imposed many regulations on the Mexican growers and handlers during the winter seasons. These regulations vary considerably. For example, a regulation may prohibit the shipment of smaller sizes, or it may even enforce a shipping embargo on exports to the United States. These regulations are imposed generally in the 8th week of the season and continue until the 26th week. Most prohibit the export of smaller sizes and lower grades.

It was therefore hypothesized that the weekly supply of large vine-ripe tomatoes from Mexico was a function of the total quantity imported each week and a qualitative variable representing the actions of UNPH (equation 18). Once the volume of large vine-ripe tomatoes was estimated, small vine-ripe tomatoes made up the rest (equation 19).

EQUATION 18

$$CILVR_w = -0.3415 + \underset{\substack{(0.01751)\\ ***}}{0.71584}\, CIVR_w + \underset{\substack{(0.1748)\\ ***}}{0.79014}\, MXDUM_w$$

$R^2 = .99$ df = 53 D-W = 1.05

EQUATION 19

$$CISVR = CIVR_w - CILVR_w$$

where

$CILVR_w$ = per capita disappearance of large vine-ripe tomatoes imported from Mexico in week w

$CISVR_w$ = per capita disappearance of small vine-ripe tomatoes imported from Mexico in week w

$CIVR_w$ = per capita disappearance of all vine-ripe tomatoes imported from Mexico in week w

$MXDUM_w$ = qualitative variable to represent the actions of the Mexican union (UNPH); equals 1 when shipping restrictions are in effect, otherwise equals 0.

F.o.b. Price Equations

The demand for mature green tomatoes was hypothesized to be a function of the quantity of Florida mature green tomatoes shipped the previous week, per capita income, and the f.o.b. price of mature green tomatoes in the previous week. The pricing techniques were discussed with selling and buying brokers in the tomato industry. The current week's price reportedly depended heavily on the prices received in the preceding week, in addition to the usual variables of total quantity available, total quantity in the pipeline, quality, and their estimates of future supplies from Mexico and Florida. Adjustments in price were made on the basis of the preceding week's price. If demand and supply seemed to support an increase in price, then prices were increased 25 or 50 cents per carton above the price of the preceding week.

Per capita income was included in the intraseasonal equation to account for the anticipated increase in product prices over time. In a particular season the effect of income on weekly prices variations was generally neutral. Yet including a variable of this type was necessary to account for the gradual price increase that was expected even without any supply-management programs. A time variable could have performed this function, but the results with per capita income (constant within each month) were preferred.

The demand equation for vine-ripe tomatoes was hypothesized to be based on factors similar to mature greens. But the quantity of Florida vine-ripe tomatoes was relatively small compared to mature green tomato shipments. So the same equation did not give satisfactory results. The vine-ripe tomato price was more sensitive to the volume in the pipeline than was the mature green tomato price. A total quantity variable was significant under negative signs with a lag of 1 and 2 weeks. Also, the price of vine-ripe tomatoes in the previous week was not a significant regressor in the various equations tested.

EQUATION 20

$$PIMG_w = -169.6 - \underset{\substack{(0.2179)\\ **}}{0.4358}\, CFMG_w - \underset{(0.8908)}{0.005769}\, CFVR_w$$

$$- \underset{\substack{(0.2020)\\ *}}{0.3985}\, CITOM_{w-1} - \underset{\substack{(0.2690)\\ **}}{0.6538}\, CFMG_{w-1}$$

$$+ \underset{\substack{(21.11)\\ **}}{53.92}\, PCDINC_w + \underset{\substack{(0.1769)\\ ***}}{0.5175}\, PMG_{w-1}$$

$R^2 = .79$ df = 21 D-W = 1.89

EQUATION 21

$$PLVR_w = -280.0 - \underset{\substack{(0.1650)\\ ***}}{0.73725}\, CFMG_w - \underset{(0.9252)}{0.071938}\, CFVR_w$$

$$- \underset{(0.2422)}{0.40166}\, CTOM_{w-1} - \underset{\substack{(0.2040)\\ ***}}{0.69079}\, CTOM_{w-2}$$

$$+ \underset{\substack{(25.41)\\ ***}}{92.577}\, PCDINC_w$$

$R^2 = .76$ df = 22 D-W - 1.23

where

$PLMG_w$ = average f.o.b. shipping point price of large mature green tomatoes in week w

$PLVR_w$ = average f.o.b. shipping point price of large vine-ripe tomatoes in week w

$CFMG_w$ = per capita disappearance of Florida mature green tomato shipments in week w

$CFVR_w$ = per capita disappearance of Florida vine-ripe tomato shipments in week w

$CITOM_w$ = per capita disappearance of Mexican imported tomatoes in week w

$PCDINC_w$ = per capita disposable income, adjusted on a monthly basis

PMG_w = average f.o.b. price of large and small mature green tomatoes in week w

$CTOM_w$ = per capita disappearance of all tomatoes in week w

The quantity of tomatoes imported in the current week was excluded from equations 20 and 21. This variable had no statistical significance when included in either equation. The effect of imports, however, was reflected in the lagged variable, CTOM, since this variable includes all tomatoes shipped in the previous week from Florida, other domestic sources, and Mexico.

Prices of the small mature green and vine-ripe tomatoes were calculated on the premise that the prices of the two size categories follow a constant pattern. This appeared reasonable since the prices for the two size categories of both maturities were highly correlated. In this project, the prices were weighted average prices for all grades and sizes. They were combined to form only two final categories based on size. If needed, prices of each size and grade category could be calculated because the price relationship between sizes and grades is fairly consistent.

In table 4 the prices of both mature green and vine-ripe tomatoes move in a step-wise fashion. If U.S. No. 1 6x6's were $4.50 per carton, then U.S. No. 1 6x7 and 6x6 combinations were $4.00. This pricing scheme can be more readily seen after examining sales invoices 8/ for a grower of tomatoes that were consistent in quality. By studying a grower's invoices, the factor of price variation because of unmeasurable quality differences can be removed.

The prices of the small mature green and vine-ripe tomatoes were determined by the direct constant relationships of the prices of the larger tomatoes. In equations 22 and 23, these relationships were calculated from price-quantity data for the 1971/72 season.

EQUATION 22

$$PSMG_w = (k1) \quad (PLMG_w)$$

EQUATION 23

$$PSVR_w = (k2) \quad (PLVR_w)$$

where

$PSMG_w$ = average f.o.b. price of small mature green tomatoes in week w

$PSVR_w$ = average f.o.b. price of small vine-ripe tomatoes in week w

k1 = coefficient expressing constant relationship between f.o.b. price of large and small mature green tomatoes

k2 = coefficient expressing constant relationship between f.o.b. price of large and small vine-ripe tomatoes

Net Returns Per Acre

Calculating net returns per acre for tomato producers was an important step in the model. Not only did it serve as an indicator of returns to growers, but it was also a part of the feedback loop supplying an integral component for the initial equations in the interseasonal phase of the model. Basically, net returns per acre for the 34-week season were calculated by substracting fixed and variable costs from gross returns and dividing by the total acreages planted.

8/ Price-quantity data were collected in the winter of 1973 from south Florida packinghouses. About 6,000 sales invoices were inspected.

Table 4--Index of price relationships between various sizes and grades of mature green and vine-ripe tomatoes 1/

Grade	Price index 2/ when the size of--									
	Mature green tomatoes is--					Vine-ripe tomatoes is--				
	5 x 6 and larger	6 x 6	6 x 7	7 x 7	7 x 8	5 x 6 and larger	6 x 6	6 x 7	7 x 7	7 x 8
U.S. No. 1	100	96	69	42	23	100	95	62	37	16
Combination	86	93	64	42	24	100	100	68	30	24
U.S. No. 2	80	75	48	31	25	96	92	74	40	16
U.S. No. 3	64	58	41	25	25	62	55	27	16	15
Ungraded	51	43	29	22	22	40	32	23	22	10

1/ Based on unpublished data from a survey conducted during winter of 1973 of 15 packinghouses in Florida. Prices and quantities from sales invoices were recorded for the entire 1971/72 season.
2/ The index is based on 100 for U.S. No. 1 tomatoes that are 5 x 6 and larger.

Retail Prices

Retail prices were calculated to determine the relative effects of the various marketing policies of the Florida Tomato Committee on domestic consumers. As with many other parts of a systems' analysis, a detailed analysis of the relationship between the f.o.b. price and the retail price for fresh tomatoes would have been possible. But it was not needed for this project. Data on the retail prices of tomatoes by maturity were quite limited, and this would be a major obstacle in such an analysis.

The results of two previous studies provide the essential parts of the retail price equations 24 and 25. Bohall (1) evaluated the pricing performance of the fresh winter tomato industry between selected shipping points and receiving wholesale terminals, that is, between the f.o.b. price and the wholesale price. The hypothesis was that the difference in wholesale price from one city to another should be accounted for by differences in shipping distance. Bohall concluded that the fresh tomato industry was behaving in a competitive manner, that is, most wholesale price differences could be attributed to transportation costs.

The transportation cost from south Florida to the New York-Ohio area was used to convert the f.o.b. prices obtained in a previous stage of this model to wholesale prices. The distance was considered representative for the tomato shipments from Florida.

The truck rate for shipping tomatoes from Ft. Pierce, Fla., to New York or Columbus, Ohio, was approximately 2.7 cents per pound in 1972/73. The rail rate between the same points was approximately 1.6 cents per pound. Since about three-fourths of Florida's tomatoes were shipped by truck, the weighted average shipping cost per pound from south Florida to New York and Ohio was estimated at 2.425 cents.

Brown and Cravens (4) conducted a research project on the retail price margins for fresh tomatoes in Ohio. Their margins for mature green and vine-ripe tomatoes were used in this project. Their distinction between mature green and vine-ripe tomatoes was based on a predominant industry practice of displaying vine-ripe tomatoes loose and packaging mature green tomatoes in tubes. The estimated margin between the wholesale and retail prices was 48.4 for mature green tomatoes and 68.4 for vine-ripe tomatoes.

One other issue discussed by Brown and Cravens was the retail industry practice of pricing tomatoes at traditional 10-cent increments, for instance, 29, 39, and 49 cents per pound. This retail pricing characteristic was incorporated in the model by setting prices at traditional levels when the estimated price fell within specified boundaries.

EQUATION 24

$$RPMG_w = (PMG_w + TW_t) \quad (148.4)$$

EQUATION 25

$$RPVR_w = (PVR_w + TE_t) \quad (168.4)$$

where

$RPMG_w$ = retail price of mature green tomatoes in week w

$RPVR_w$ = retail price of vine-ripe tomatoes in week w

PMG_w = average f.o.b. price received for Florida mature green tomatoes in week w

PVR_w = average f.o.b. price received for Florida vine-ripe tomatoes in week w

TE_t = average transportation expense for shipping Florida tomatoes in year t

Consumer Expenditure for Tomatoes

Equations 26 and 27 in the intraseasonal phase of the model were used to determine the total pounds and the total annual expenditure by domestic consumers for Florida and Mexican tomatoes in each year. These values were used to evaluate the relative effects on consumers and handlers from various marketing policies of the Florida Tomato Committee and on imports from Mexico.

EQUATION 26

$$CEXP_t = \sum_{w=1}^{34} (RPMG_w) \quad (QMG_w) + (RPVR_w) \quad (QVR_w)$$

EQUATION 27

$$VOL_t = \sum_{w=1}^{34} (QMG_w + QVR_w)$$

where

$CEXP_t$ = total consumer expenditure for mature green and vine-ripe tomatoes from Florida and Mexico in year t

QMG_w = total quantity of mature green tomatoes shipped from Florida and Mexico in week w

QVR_w = total quantity of vine-ripe tomatoes shipped from Florida and Mexico in week w

VOL_t = total quantity of all tomatoes shipped from Florida and Mexico in year t

Several other summarizing equations were included in the model to calculate the values needed for endogenous variables lagged in the following time period of the interseasonal phase. This included calculating the average yield per acre, total quantity of Florida mature green and vine-ripe tomatoes shipped, total quantity of Mexican tomatoes imported, total Florida acreage harvested, and the average f.o.b. prices for the season.

SIMULATION OF THE WINTER FRESH TOMATO SUBSECTOR

Validation of the model, design of the experiments, and results of the experiments are covered in this section.

Validation of the Model

Validation of the model was necessary to evaluate the impact of alternative policies in the simulation experiments. Validation generally means that the researcher must be satisfied that the model can adequately characterize the system it is intended to represent. 9/

The major part of the final validation process was conducted as a two-step procedure. First, the simulation model was carried over a historical period. Results for this period were compared with the actual data from the period. In the interseasonal phase, the major concerns were the number of turning points, direction of the turning points, and amplitude of fluctuations for corresponding time segments. 10/ In the intraseasonal phase, primary concern was with the mean values of target variables and their variance.

The second part of the final validation process was to generate output over future time periods and to evaluate it for reasonableness. The interseasonal and intraseasonal phases were investigated for logical consistency and predictive ability. They were judged to be adequate representations of the winter fresh tomato industry for the experimental purposes of this analysis.

9/ Validating simulation models is a complex and often overwhelming problem that can easily be expanded beyond the sophistication of the model being analyzed. The one basic issue of validation in this study was a concern over the adequacy of the model to generate meaningful values of specific endogenous variables. Validation was continually exercised during the construction, testing, and revision of the model.

A good review of system analysis and validation of simulation models is presented by Johnson and Rausser (13). Also discussion of multistage validation, which incorporates the methodology of rationalism, empiricism, and positive economics is presented by Naylor (17).

Orcutt (22) refers to this as a building-block approach where individual sections are tested and modified during the construction stage. Hamilton (10) also discusses this concept of the continual and simultaneous nature of model building and validation. Meier (15, p. 294) said that care exercised in the formulation and construction of the model is as important as more specific procedures for validating a model after it is constructed.

10/ See Cyert (5) for a discussion of selecting a suitable set of criteria for evaluating the "goodness of fit" on a computer simulation model.

To complete the historical validation process for the interseasonal phase of the model, annual price functions (equations 28 and 29) for mature green and vine-ripe tomatoes were formulated. These functions were used only when the interseasonal phase was simulated without the intraseasonal phase. With these added equations, the interseasonal phase could actually be dealt with as a separate, complete simulation model in itself. The underlying hypothesis concerning these price functions was that the f.o.b. price of fresh tomatoes in Florida is primarily a function of the quantity produced in Florida, the quantity imported, and the incomes of consumers.

EQUATION 28

$$PMG_t = 7.700 - \underset{\substack{(1.215)\\ ***}}{4.4873}\ CITOM_t - \underset{(0.6890)}{0.35597}\ CFVR_t$$

$$- \underset{\substack{(0.9901)\\ **}}{2.9587}\ CFMG_t + \underset{\substack{(0.00108)\\ ***}}{0.006995}\ PCDINC_t$$

$R^2 = .92$ df = 11 D-W = 1.88

EQUATION 29

$$PVR_t = 9.966 - \underset{(2.551)}{3.4827}\ CITOM_t - \underset{(2.078)}{2.9404}\ CFMG_t$$

$$- \underset{(1.446)}{1.1171}\ CFVR_t + \underset{\substack{(0.002272)\\ ***}}{0.006932}\ PCDINC_t$$

$R^2 = .82$ df = 11 D-W = 1.40

where

PMG_t = average annual f.o.b. price for Florida mature green tomatoes in year t

PVR_t = average annual f.o.b. price for Florida vine-ripe tomatoes in year t

$CFMG_t$ = per capita disappearance of Florida mature green tomatoes in year t

$CFVR_t$ = per capita disappearance of Florida vine-ripe tomatoes in year t

$PCDINC_t$ = per capita disposable income in year t

$CITOM_t$ = per capita disappearance of imported tomatoes in year t

The primary target variables in the simulation of the historical period were the acreages planted and harvested in Florida, the quantities produced in Florida, the quantities imported from Mexico and the average f.o.b. prices received for Florida tomatoes. Next, predictions are compared to the real values for these 10 target variables. Figure 2 gives the simulation model predictions and the actual values of Florida acreages planted in mature green and vine-ripe tomatoes. The overall comparison was quite favorable. Directional changes from year to year were all consistent for mature green tomato acreages. Except for 1969/70, the simulated results were very close to the actual values.

The predicted values for planted vine-ripe tomato acreages followed the directional changes of actual values nearly as well as those of mature green tomatoes. During the 1965/66 season, the Florida acreage planted in vine-ripe tomatoes reached a record level that was duplicated by the simulated value in direction but not in amplitude. Over the last part of the historical period, the simulated and actual values were very close but missed the directional changes in two instances.

Predicted values from the simulation model were even closer to the actual values when considering the acreages harvested (fig. 3). This can be partly attributed to the effect of Mexican imports which are included as independent variables in these functional relationships. For mature green tomato acreages, the discrepancy between the predicted and actual values for the 1969/70 season was reduced considerably.

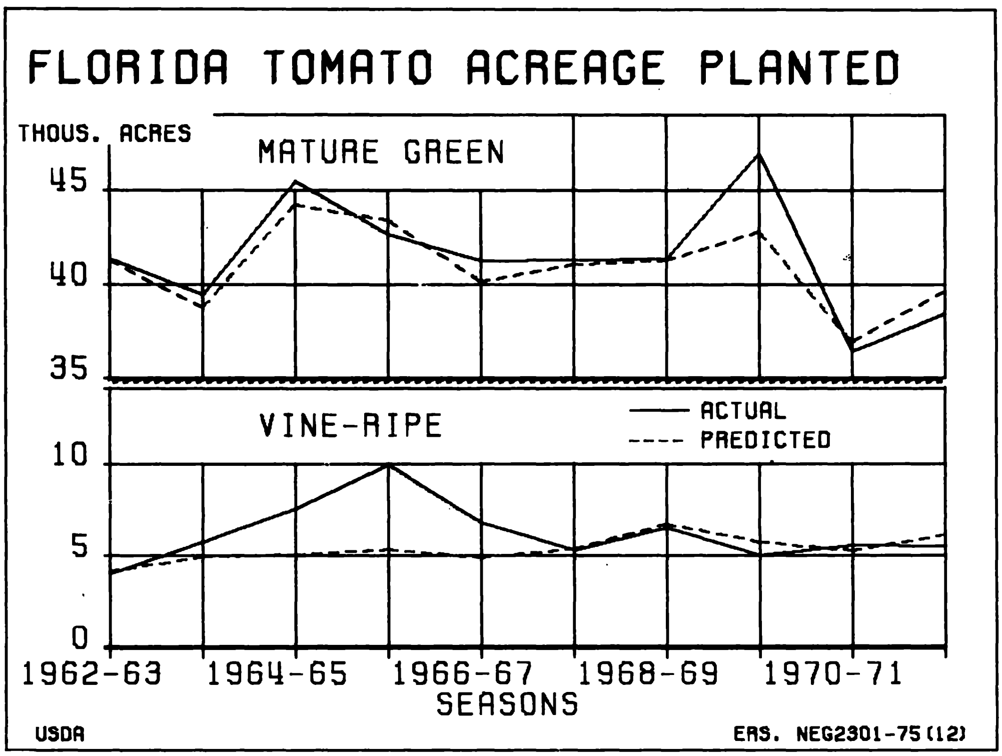

Figure 2

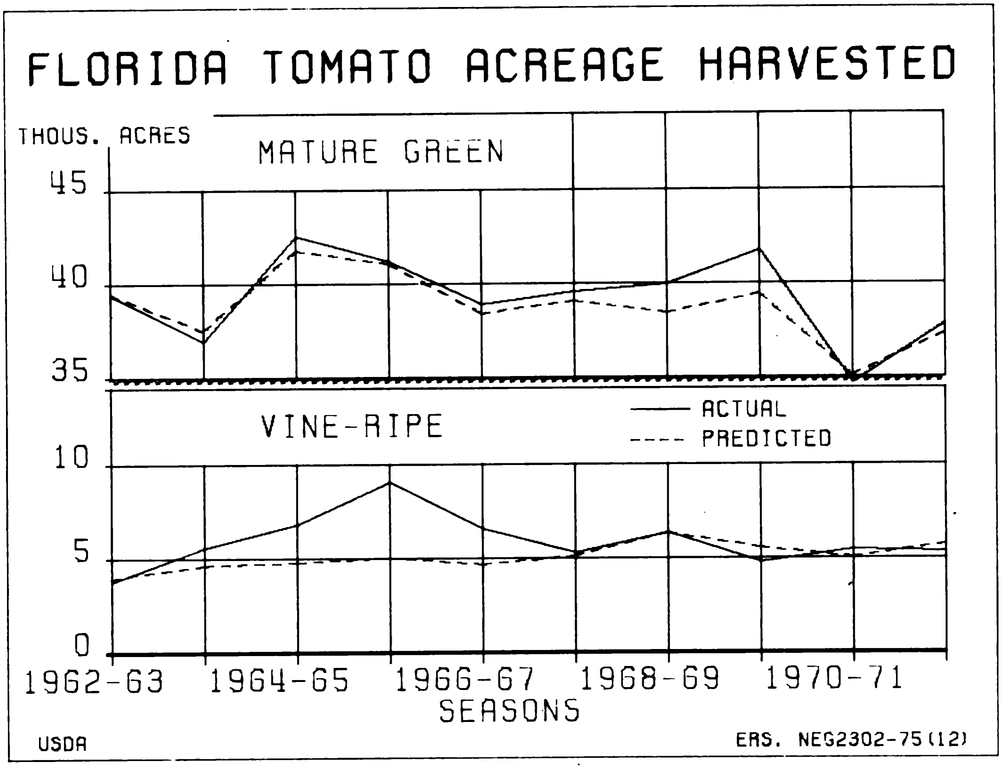

Figure 3

The simulation model predictions and the actual volumes of mature green and vine-ripe tomatoes from Mexico and Florida are shown in figures 4 and 5. They show reasonably close relationship between predicted and actual values. Likewise, the major turning point for Mexican mature green tomatoes in 1967/68 was reflected in the simulation predictions.

The volumes of Florida mature green tomatoes predicted in the simulation model were very close to the actual volumes over the entire 10-year historical period. Although the predictions of Florida vine-ripe tomatoes were astray in the first few seasons, the last 5 seasons were very closely predicted. The Florida volumes were calculated by multiplying yield by acreage harvested. Yields per acre were not estimated in the historical simulation of the interseasonal phase but were set at the actual historical values.

In the validation procedure of the interseasonal phase, the major concern was with the predictions of Florida acreages and Mexican volumes. The predictions of f.o.b. prices by the interseasonal phase were reasonable but not so satisfactory as the other predicted variables (fig. 6). Both price equations for this stage were adequate from a statistical standpoint, but they were not able to reflect the drops in price from 1964/65 to 1965/66 and from 1968/69 to 1969/70. This was largely a result of the error in predicting the tomato volume for these periods. But the directional change from year to year for the predicted and actual f.o.b. price was consistent 7 of 9 times for vine-ripe tomatoes and 6 of 9 times for mature green tomatoes. For the last 2 years, the predicted f.o.b. prices were higher than the actual prices because of the lower import volumes predicted for Mexican mature green and vine-ripe tomatoes.

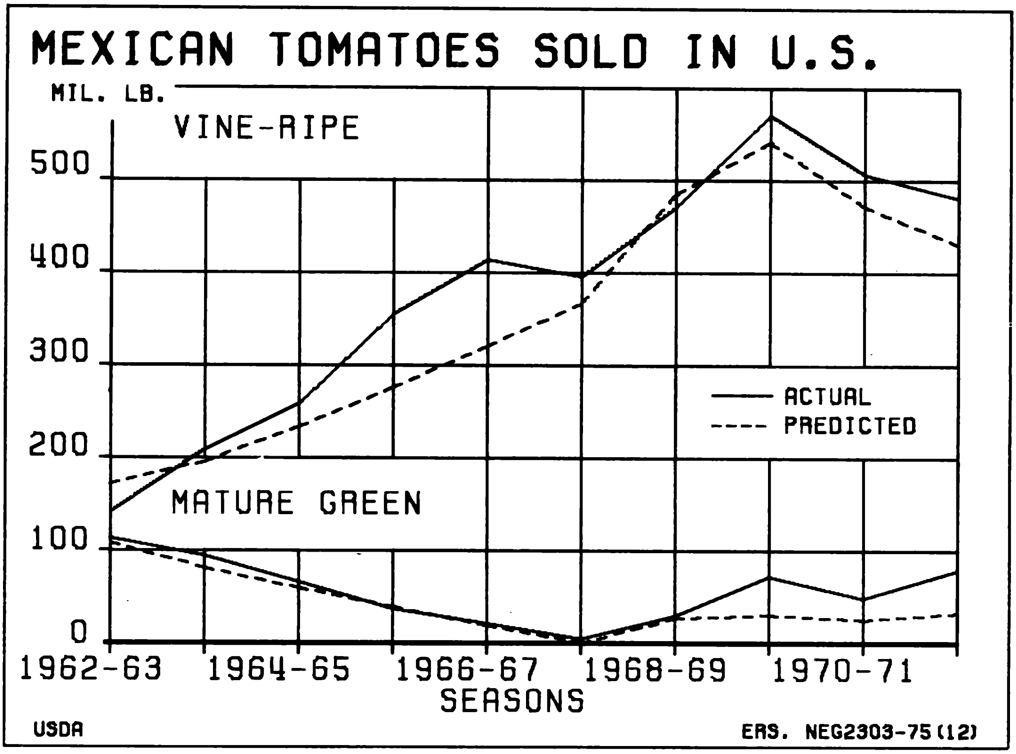

Figure 4

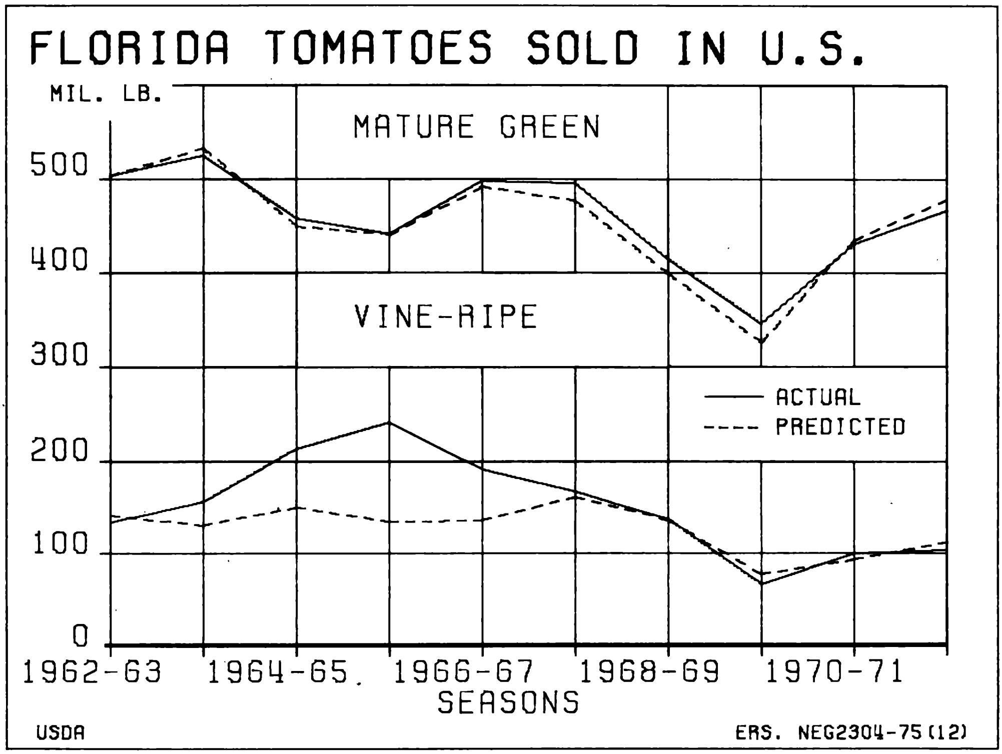

Figure 5

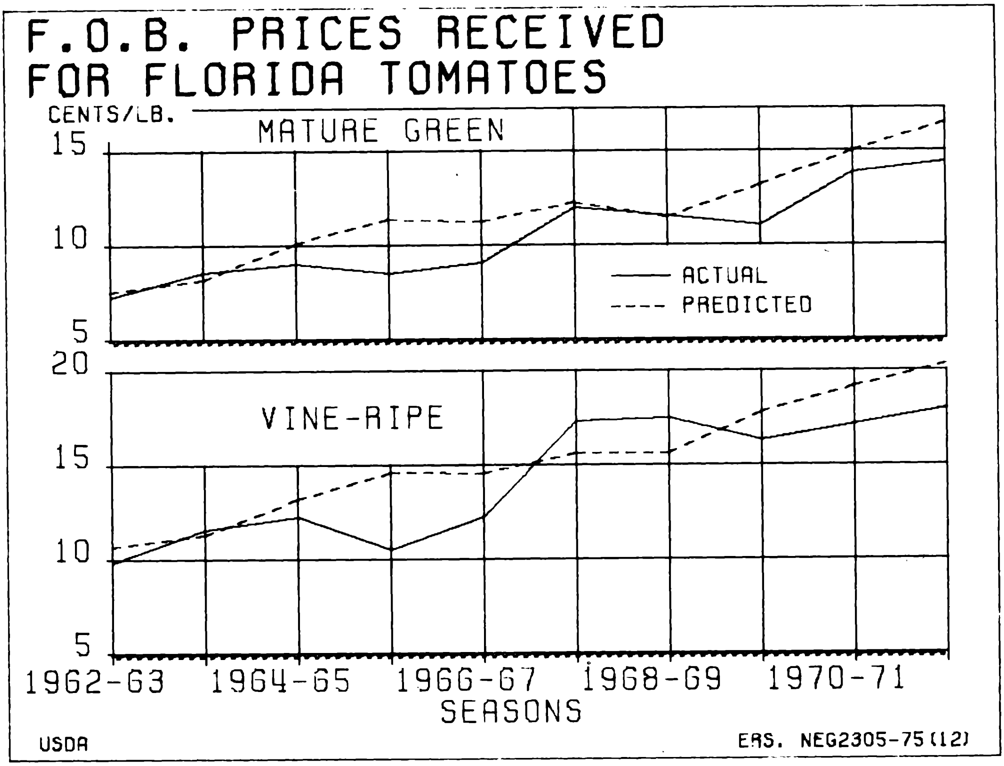

Figure 6

The interseasonal phase of the model adequately represented the U.S. winter fresh tomato industry because the historical simulation reproduced the recorded historical values. Variability of the weekly f.o.b. prices was measured by a coefficient. The coefficients of variation for the actual series of weekly prices were 29.0 for large mature green tomatoes and 22.0 for vine-ripe tomatoes during the 1970/71 season. The coefficients of variation were 27.8 for the predicted large mature green tomatoes and 33.4 for vine-ripe tomatoes.

The level and range of the predicted prices were also quite acceptable. The actual prices for the large mature green tomatoes ranged from 9.04 to 28.63 cents per pound during the 1970/71 season, and predicted prices ranged from 7.54 to 32.25 cents. Actual prices for large vine-ripe tomatoes ranged from 11.7 to 32.19 cents per pound, and the predicted prices ranged from 5.87 to 33.98 cents. Only three of the predicted mature green tomato prices were outside the range of the actual prices and these were predicted prices for the first week and the last 2 weeks of the season. This was also true for vine-ripe tomatoes, except that a very low price was predicted for the 28th week.

The projected weekly prices also followed the same cyclical pattern of the actual prices. The intraseasonal phase of the model is an adequate representation of the winter fresh tomato industry because of the coefficients of variation, the accuracy of the model to predict prices in the historical range, and the ability of the model to recreate the general cyclical pattern of the historical prices.

SIMULATION EXPERIMENTS

To evaluate potential alternative policies, a base situation was created so that the responses of the experiments could be compared. 11/ The base situation was an experiment itself since no supply restrictions were in effect. The selected set of initialized values and projections of the exogenous variables in the base situation were used to generate the endogenous variables that become benchmark values. Then the response variables from the simulation experiments were generated and compared against these benchmark values (see table 1 for model specifications and assumptions).

Base Situation

Table 5 gives the projected exogenous variables that are determined by economic factors outside the system and are used to define the base situation. These projections were made in various ways to reflect recent trends. But emphasis should be placed on the relative differences between variables that are determined by the system (endogenous) and not on the projected exogenous variables.

The first values for the lagged endogenous variables were calculated from actual values of these variables during the previous few years, or they were set at reasonable starting points. A primary concern was to avoid setting these first variables at abnormal levels (15, p. 296). The net returns per acre were set at $120.94 for mature green tomatoes and $225.71 for vine-ripe tomatoes. Florida harvested acreage was set at 37,830 for mature green tomatoes and 5,310 for vine-ripe tomatoes. Consumer consumption of imported mature green tomatoes was set at 0.3794 pounds per capita and of imported vine-ripe tomatoes at 2.3114 pounds.

Several problems were encountered in the first computer runs of the base situation. The most serious problem was the calculation of net returns per acre for Florida mature green and vine-ripe tomatoes. This was partly anticipated because of the difficulty in obtaining consistent cost figures for producing the marketing tomatoes. Predicting the Florida acreage planted as mature green and vine-ripe tomatoes included the value of net returns per acre from the preceding season. Although this lagged net return per acre variables was not significant in the equation for vine-ripe tomatoes, it was highly significant in the one for mature green tomatoes. This variable proved to be very sensitive in predicting the acreage of mature green tomatoes planted each season. An abnormally high or low net return value set the model on an explosive course. To control this, a set of upper and lower bounds was incorporated. 12/

11/ Naylor suggested that simulation experiments be broadly classified in two types. One type maximizes or minimizes a particular response variable to optimize some process; the other type shows the general relationship of the response surface to changes in the system (12 and 18). The experiments in this part of the tomato industry analysis are in the second type.

12/ Setting these bounds for the net return per acre values of mature green and vine-ripe tomatoes did not impair the operation of the model or prohibit it from generating meaningful results. It merely kept this vital variable from expanding beyond the point of reasonableness, which would not have occurred if the model could have reacted rapidly enough in the intraseasonal phase.

Table 5--Projected exogenous variables used in the base model and four simulation experiments 1/

Season	Per capita disposable income 2/ (PCDINC)	Population 3/ (PØP)	Index of prices paid 4/ (IPP) 1910-14=100	Index of prices received, 10-year average 5/ (IPR) 1910-14=100	Quantity of tomatoes from domestic sources other than Florida 6/ (QØTØM)
	Dollars	Millions			Million pounds
1972/73	3,550	210.07	440.9	311.0	224.19
1973/74	3,555	212.60	460.1	321.8	228.68
1974/75	3,560	215.16	480.5	333.4	233.25
1975/76	3,565	217.75	502.0	345.6	237.91
1976/77	3,570	220.38	524.6	358.6	242.67
1977/78	3,575	223.04	548.4	372.3	247.53
1978/79	3,580	225.72	573.2	386.7	252.48
1979/80	3,585	228.45	599.2	401.9	257.53

1/ Source of basic data is (24).

2/ Designed to shift the intercepts of the weekly demand equations (4.20 and 4.21) so that the increase in the annual price for fresh tomatoes in 1979/80 corresponds to the increase in the Index of Prices Received.

3/ Estimated to increase at the annual rate of 1.2 percent each year.

4/ Indexes for 1973 through 1980 predicted from:

$$IPP_t = 287.75 - \underset{\substack{(1.272)\\ *}}{2.580T_t} + \underset{\substack{(0.065)\\ ***}}{0.560T_t^2} \qquad R^2 = .98$$

5/ Indexes for 1973 through 1980 predicted from:

$$IPR_t = 242.22 - \underset{\substack{(1.615)\\ *}}{3.220T_t} + \underset{\substack{(0.083)\\ **}}{0.360T^2} \qquad R^2 = .88$$

6/ Estimated to increase at the rate of 2 percent each year.

The upper bound for the lagged net return value was set slightly above the highest value recorded over the past 10 years in Florida. Likewise, the lower bound was set slightly below the lowest net return value over the same period. For mature green tomatoes, this set the range from a negative \$50 to a positive \$175 per acre. Vine-ripe tomatoes had a range from a negative \$300 to a positive \$1,350 per acre.

The cost of growing, harvesting, hauling, packing, and selling mature green and vine-ripe tomatoes in Florida was synthesized from Brooke's costs and returns covering the 1971/72 season (2). Growing the tomatoes was considered a fixed expense that did not vary with the quantity harvested. On this basis in this project the cost was \$950 per acre for producing mature green tomatoes and \$1,950 for vine-ripe tomatoes during the 1971/72 season. The cost of picking, hauling, packing, and selling was 6.5 cents per pound for mature green tomatoes and 7.0 cents for vine-ripe tomatoes. If any tomatoes were dumped at the packinghouse, the cost of picking and hauling was set at 3.0 cents per pound for vine-ripe tomatoes. For each year, these costs were adjusted by the predicted Index of Prices Paid for each season. All of the cost per pound values used to calculate retail prices were also increased annually so that they were directly related to the Index of Prices Paid.

Experiments

The first simulation experiment was designed to investigate the effect on the fresh winter tomato industry of stabilizing the f.o.b. prices during the marketing season at pre-specified levels during the longer 8-year run. These price levels were expressed as 75 and 100 percent of the parity price for fresh tomatoes.

In this simulation, the supply of tomatoes imported from Mexico was not restrained and was estimated by the functional relationships (equations 3 and 4). Also, the supply restrictions needed to stabilize the f.o.b. prices of mature green and vine-ripe tomatoes at the desired level were imposed only on Florida supplies.

These restrictions were incorporated to evaluate the effect of Mexican supplies not restricted by the regulations of Florida's marketing order. Section 8e of the Agricultural Marketing Agreement Act imposes the same restrictions on imports as on domestic shipments covered by a Federal Marketing Order. The evaluation also enables the comparison of the outputs of experiments I and II.

The second reason for restricting only Florida shipments in this experiment was to evaluate the effect of possible legal action prohibiting the use of discriminatory size restrictions between tomato forms. Since Florida produces primarily mature green tomatoes and Mexico primarily vine-ripe tomatoes, this assumption involves the controversy over using discriminatory size regulations. In this simulation, size discrimination was practiced by categorizing the 6x7 size of vine-ripe tomatoes as small and the 6x7 size of mature green tomatoes as large. So, if only Florida tomatoes (mostly mature green) were restricted, the shipments of 6x7 vine-ripe tomatoes would not be affected by supply restrictions. Thus, Mexican tomatoes would be virtually unaffected by a supply restriction since Mexico exported very few 7x7 and 7x8 sizes of vine-ripe tomatoes.

Where the marketing policy was to stabilize prices at prespecified levels (experiments I, II, and III), the same procedure was used. First, the total quantity available for market was estimated for each week of the intraseasonal phases. Second, the weighted average f.o.b. price of Florida tomatoes was calculated. Then this price was compared to the specified price to determine whether a supply regulation should be imposed on the shipments of the smaller sized tomatoes. If a supply regulation was imposed, an adequate volume (or all) of the smaller sized tomatoes was dumped at the packinghouse stage in an attempt to raise the weighted price to the specified price level. The f.o.b. price goal was not always obtained since the volume of smaller sized tomatoes dumped could be inadequate to raise the price to that level.

Simulation Results

Projections of the endogenous variables are presented in the appendix. The graphs are summarized on an annual basis and show trends that developed.

Values of 12 endogenous variables are presented in table 6. The first row of data shows the values generated by the base situation for each variable in the first and last years of the simulation. Deviations from the base situation values are also listed.

For experiments I, II, and III, the f.o.b. price goal was set at two levels for each experiment. When the price goal was set at 100 percent of parity, the results were represented by the capital letter A. Likewise, when the price goal was set at 75 percent of parity, the results were represented by the letter B.

Also, the results from the simulation model were used to evaluate the relative effects on growers, handlers, importers, and consumers. It was assumed that the goals of each group varied and that the aim of Florida growers was primarily to obtain high total net returns. Handlers of Florida tomatoes (packinghouse operators) were assumed to be more concerned with high volume than price since they charged on a per unit basis. Import handlers, on the other hand, were concerned with both volume and price, because they received a per unit fee plus a commission based on sales revenue. Domestic consumers were concerned with lower retail prices and higher volumes for consuming.

Evaluating the output from experiments in terms of the benefits for several groups of participants can be more readily accomplished in a study that maximizes the benefits for one group of participants. So to improve the evaluation, an index was created by setting the base, or free market, situation at 100 (table 7). 13/ The factors used as performance criteria were intended to show the

13/ To evaluate the effects of the experiments, some aggregation criterion, or weights, is required. Weights permit the user to choose the "best" course of action for those choices examined. For example, if equal weights were given to each group of participants, policies of experiment III-A would be the preferred choice, that is, the highest average index. The obvious question here is the legitimacy of combining the indexes of the four participant groups. A check of the indexes in table 7 reveals the dominant magnitude of the index for total net revenue of Florida growers of vine-ripe tomatoes. Therefore, before any conclusions can be drawn regarding the overall effects of alternative marketing policies on participants collectively, the decisionmaker must subjectively formulate a set of "weights" which will enable him to select the "best" policy.

Table 6--Values of endogenous variables generated by the base model and four simulation experiments for the 1972/73 and 1979/80 winter seasons

Model 1/	Florida acreage planted to 2/--				Florida quantity shipped of 2/--				Average f.o.b. price of 2/--			
	Mature green tomatoes (PAFMG)		Vine-ripe tomatoes (PAFVR)		Mature green tomatoes (QFMG)		Vine-ripe tomatoes (QFVR)		Mature green tomatoes (PMG)		Vine-ripe tomatoes (PVR)	
	1972/73	1979/80	1972/73	1979/80	1972/73	1979/80	1972/73	1979/80	1972/73	1979/80	1972/73	1979/80
	Acres				Million pounds				Cents per pound			
Base	39,578	38,223	5,384	4,813	449.24	440.93	101.39	94.64	17.26	21.25	20.00	23.59
	Deviations from base model											
Experiment: 3/												
I-A	0	-1,537	0	1,070	-10.69	-69.30	-2.27	4.81	1.61	3.62	1.78	5.28
I-B	0	994	0	332	-8.29	-2.86	-1.40	1.68	1.20	1.28	.91	1.31
II-A	0	2,414	0	1,609	-10.69	-12.18	-2.27	13.28	1.63	3.24	1.78	5.16
II-B	0	2,900	0	287	-8.29	14.95	-1.40	1.85	1.20	1.13	.91	1.32
III-A	0	2,347	0	1,585	-18.09	-25.15	-2.37	12.69	1.30	3.81	1.06	5.57
III-B	0	2,356	0	92	-16.98	6.54	-1.84	-0.42	.91	1.11	.19	.86
IV	0	-1,178	0	-205	-4.10	-12.36	.59	-2.51	-0.25	.14	-0.73	-0.27

Model 1/	Quantity imported from Mexico of 2/--				Florida quantity dumped of--				Net returns per acre for 2/--			
	Mature green tomatoes (QIMG)		Vine-ripe tomatoes (QIVR)		Mature green tomatoes (QDFMG)		Vine-ripe tomatoes (QDFVR)		Mature green tomatoes (NRFMG)		Vine-ripe tomatoes (NRFVR)	
	1972/73	1979/80	1972/73	1979/80	1972/73	1979/80	1972/73	1979/80	1972/73	1979/80	1972/73	1979/80
	Million pounds								Dollars per acre			
Base	106.77	252.43	459.79	395.93	--	--	--	--	235.16	92.10	429.80	23.73
	Deviations from base model											
Experiment: 3/												
I-A	0	-26.38	0	151.95	11.02	40.34	2.23	10.04	143.39	128.81	259.45	395.61
I-B	0	3.13	0	20.95	8.47	9.08	1.40	1.94	104.71	90.06	126.26	150.15
II-A	0	57.46	-33.64	-86.70	11.02	42.15	2.23	10.04	143.39	127.22	259.45	398.73
II-B	0	26.95	-24.40	-56.52	8.47	9.37	1.40	1.90	104.71	61.22	126.26	130.80
III-A	-32.69	-175.78	65.96	146.26	10.93	43.19	2.15	10.40	79.82	189.48	114.13	460.59
III-B	-32.90	-175.78	64.53	146.26	8.52	9.13	1.37	1.89	39.79	51.96	-30.81	85.00
IV	-32.11	-175.78	70.08	146.26	--	--	--	--	-39.40	20.76	-125.49	-9.69

1/ See table 1 for explanation of the base model and experiments. 2/ For reference purposes, the actual 1971/72 values for these variables were: PAFMG = 28,406; PAFVR = 5,491; QFMG = 466.00; QFVR = 102.88; PMG = 14.41; PVR = ;8.00; QIMG = 79.00; QIVR = 481.24; NRFMG = 131.72; and NRFVR = 458.99. 3/ A and B denote prespecified f.o.b. price goals of 100 and 75 percent of parity, respectively.

Table 7--Relative position of selected criteria that show the effect on participants for the four experiments over the simulated time period

Participant and criterion	Experiments (base model = 100)						
	I-A	I-B	II-A	II-B	III-A	III-B	IV
Florida growers--							
high total net renenue:							
mature green tomatoes	132.5	137.2	158.3	135.6	188.9	136.7	94.1
vine-ripe tomatoes	294.2	149.4	352.9	149.4	390.8	137.9	79.3
Florida handlers--							
high volume shipped:							
mature green tomatoes	88.6	95.9	98.3	99.5	97.9	101.3	100.6
vine-ripe tomatoes	100.8	99.9	107.8	101.1	108.0	100.8	98.4
Import handlers-- 1/							
high volume shipped:							
mature green tomatoes	94.6	101.3	116.4	108.4	40.3	40.2	40.4
vine-ripe tomatoes	113.9	101.7	86.1	91.8	117.4	117.3	117.6
high f.o.b. price:							
mature green tomatoes	112.6	106.4	111.0	105.6	113.1	105.4	99.7
vine-ripe tomatoes	117.8	104.9	116.8	104.6	117.9	103.3	98.7
Consumers-- 2/							
low retail price: 3/							
mature green tomatoes	93.2	98.3	93.6	98.6	92.8	98.7	100.1
vine-ripe tomatoes	86.0	97.2	85.9	97.4	86.0	99.4	101.4
high volume consumed:							
mature green tomatoes	90.4	97.5	103.8	102.2	80.6	82.9	82.5
vine-ripe tomatoes	111.6	101.4	89.9	93.4	115.7	114.4	114.2

1/ Import handlers are affected by both volume and f.o.b. price, because they operate on the basis of a fixed fee per carton plus an *ad valorum* charge.
2/ Consumers required two entries since low total consumer expenditure can be achieved by low volume and high prices.
3/ Retail prices and f.o.b. prices are not perfectly correlated. Also, the index for retail prices was reversed since the consumer desires low prices, so the higher the index number, the lower the average retail price.

relative effect of various supply-management programs on the four groups. The relative effects of the various experiments for each group can be directly compared by using the index numbers.

Florida Growers

Many conclusions and implications can be drawn directly from the coefficients of the equations used in the model, for example, price flexibility and income elasticity. Of course, most of the interpretive analysis of the simulation results was based on values generated over the time period and not on the average annual values. Graphic and regression analyses were used to evaluate the simulation results over the specified time period.

A brief summary of the effect of each experiment on Florida growers, in comparison to the base situation, can show the kind of information this study provides. Total net returns to Florida growers of mature green and vine-ripe tomatoes were calculated for each year. Total net returns for the base situation were subtracted from the corresponding year for each experiment (table 8). These differences were then regressed on time to determine the sign and magnitude of the equation's slope coefficient.

Several conclusions can be drawn from the time regression of differences in total net returns. In experiment I where marketing order restrictions were not imposed on Mexico, growers of Florida mature green tomatoes would prefer the less restrictive program of striving for 75 percent of parity. But growers of vine-ripe tomatoes would prefer the more restrictive program of striving for 100 percent of parity. This conflict of interest was not expected. With total net returns for vine-ripe and mature green tomatoes combined, their preferred policy was the more restrictive program.

In experiment II when the marketing order restrictions were applied to Mexican imports as well as to Florida supplies, the Florida growers preferred the more restrictive program. This was individually and collectively true for the mature green and vine-ripe tomato growers.

When an import quota as well as the marketing order restrictions were imposed on Mexican tomatoes, the positive slopes of the coefficients for the time period show that Florida growers prefer the most restrictive supply policy. This was not expected since it was hypothesized that stringent marketing order restrictions would not be necessary with a mandatory import quota. By applying various import quotas, the experiments show critical points where the slope coefficient changed sign and measure the effects on all participants.

In this study, stabilizing the weekly f.o.b. prices of Florida tomatoes was an integral part of the supply-management strategy of the Florida tomato industry. The 8-year average value of all coefficients of variation for the base situation's projected weekly f.o.b. prices of large mature green tomatoes was 24.3 percent (table 9). The model tends to dampen the intraseasonal price variation. The base situation's coefficient of variation was 30.5 percent in 1972/73 and only 21.8 percent in 1979/80. This production price variation evidently results from the way the model was constructed and not from the price stabilization programs.

Table 8--Deviations of four experiments from the base situation for total net returns to Florida mature green and vine-ripe tomato growers

Season	Experiment						
	I-A	I-B	II-A	II-B	III-A	III-B	IV
	Million dollars						
1	6,616	4,502	6,616	4,502	3,506	1,280	-2,115
2	103	-2,997	4,386	-1,002	10,771	6,518	2,651
3	4,264	5,042	3,202	3,190	5,771	855	-2,072
4	1,046	1,250	5,665	2,201	10,017	4,183	-598
5	4,719	5,502	7,134	4,751	10,063	3,734	-1,856
6	4,897	4,916	9,379	5,664	11,466	4,753	-597
7	2,276	481	3,595	-591	5,816	-1,397	-616
8	6,549	4,082	7,651	3,188	10,097	2,512	572
PV 1/	19,935	14,600	31,055	14,495	43,682	15,506	3,236

1/ Present value of net returns of the eight seasons at 10 percent discount rate.

Table 9--Coefficients of variation for projected weekly prices of large mature green tomatoes for each season of the base model and four experiments

Season	Base model	Coefficient of variation for experiment 1/--						
		I-A	I-B	II-A	II-B	III-A	III-B	IV
		Percent						
1972/73	30.5	23.6	25.1	23.6	25.1	24.5	26.0	31.1
1973/74	28.9	22.0	24.0	21.9	24.0	19.7	21.8	27.6
1974/75	23.3	17.4	18.9	18.7	19.6	17.2	19.4	24.2
1975/76	22.1	15.0	16.4	16.1	16.8	14.4	16.7	22.4
1976/77	24.1	16.8	18.5	17.9	19.0	16.2	19.1	24.9
1977/78	24.8	17.6	18.2	18.8	18.7	17.7	19.1	25.1
1978/79	18.8	14.8	15.6	15.6	15.9	14.4	16.2	18.8
1979/80	21.8	17.0	17.0	17.8	17.3	16.3	17.2	21.2
Average	24.3	18.0	19.2	18.8	19.6	17.6	19.4	21.6

1/ Coefficient of variation expresses the standard deviation as a percentage of the mean price.

The reduction in price variation that can be attributed to the supply-management programs is shown by comparing the coefficient of variation calculated for the various experiments with that for the base situation. For example, the price variation was reduced from an average of 24.3 in the base situation to 17.6 percent in experiment III-A (table 9). The import quota alone, experiment IV, reduced the price variation below that obtained for the base, but it was less successful than experiments I, II, or III. This pattern holds for individual years as well as the average for all years.

Florida Handlers

Florida handlers were primarily interested in high volume. In experiment I-A the annual volume of mature green tomatoes continually declined, and in experiment I-B it continually increased. Thus, the more restrictive program of striving for 100 percent of parity could, in the long run, greatly diminish the volume of Florida's mature green tomatoes.

Experiment II imposed the same market order regulations on imports from Mexico and lessened the decline of Florida's mature green tomato shipments over the projected timespan. Moreover, it tended to stabilize the volume of tomatoes dumped at the packinghouse level as required by marketing order restrictions for experiment II-B. All three 100 percent parity or "A" experiments (I-A, II-A, and III-A) followed a trend of increasing volumes of dumped tomatoes each year. Experiments II-B and III-B showed a fairly stable dumped volume. In experiments I-A, II-A, and III-A, the number of weeks per season in which tomatoes were dumped increased each year. With experiments I-B, II-B, and III-B, tomatoes were dumped 50 percent as much as they were in the "A" experiments during the first year and approximately 30 percent as much during the eighth year.

Import Handlers

Import handlers desire larger volumes and higher prices. With no market order or import quota restrictions (experiment I), the import handlers would prefer to strive for 100 percent of parity (I-A). Instead of vine-ripe tomato imports declining, as in the base situation and experiment I-B, the annual volume increased each year as expected.

By applying Federal Market Order regulations to Mexico as well as to Florida (experiment II), Mexico's mature green tomato industry expands more rapidly than in the base situation and the vine-ripe tomato segment declines more rapidly. In experiments III and IV that involve mandatory import quotas, the historical level of vine-ripe and mature green tomato imports was preserved. This was contrary to the base model's trends of declining vine-ripe tomato imports and expanding mature green tomato imports.

Consumers

The marketing policy programs evaluated in this study had undesirable effects on consumers, as expected. Specifically, retail prices were higher and the total quantity of tomatoes consumed was reduced in relation to the base situation. Less fluctuation in weekly supplies and in prices of tomatoes occurred as a result of the supply controls. So if consumers desire greater price stability, some benefit can be assumed.

Information generated by the model showed the magnitude of effects on consumers of various supply-management policies. For example, in experiment II-A the average retail price increased 9.5 percent, and the volume consumed declined 2.7 percent. On the other hand, retail prices increased by only 1.7 percent in experiment II-B, which had more moderate shipping restrictions, and the volume consumed declined by only 1.9 percent.

THE NEED FOR FURTHER RESEARCH

In future research more accurate information would be desirable on the total production of tomatoes in Mexico and on Mexican domestic demand.

Estimating supply relationships in the Florida sector could be improved by restructuring the model in two ways. One way would be to develop supply relationships for each of the four production districts in Florida as defined by the Federal Marketing Order. The second way would be to divide the one seasonal time period of the interseasonal phase into three seasons. This would replace the one 34-week winter season with the three traditional seasons of fall, winter, and spring, because regulations to restrict supplies affect production districts of Florida differently (14, p. 14). But this type of restructuring was not possible, because adequate data were not available.

One part of the intraseasonal phase of the model that needs further research is the determination of the acreage to be harvested each week. Collection of information on acreages harvested each week has been complicated in the past by the practice of multiharvesting. Collecting data may be easier in the future if mechanical harvesting with its once-over destructive harvesting procedure is developed and adopted by most of the industry.

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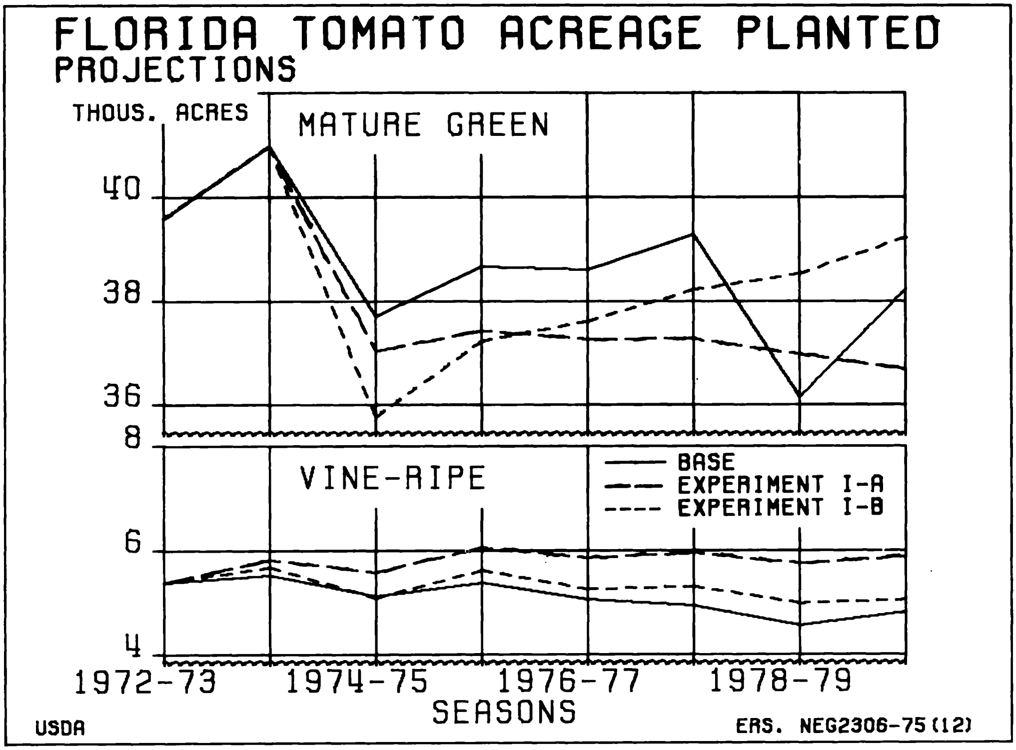

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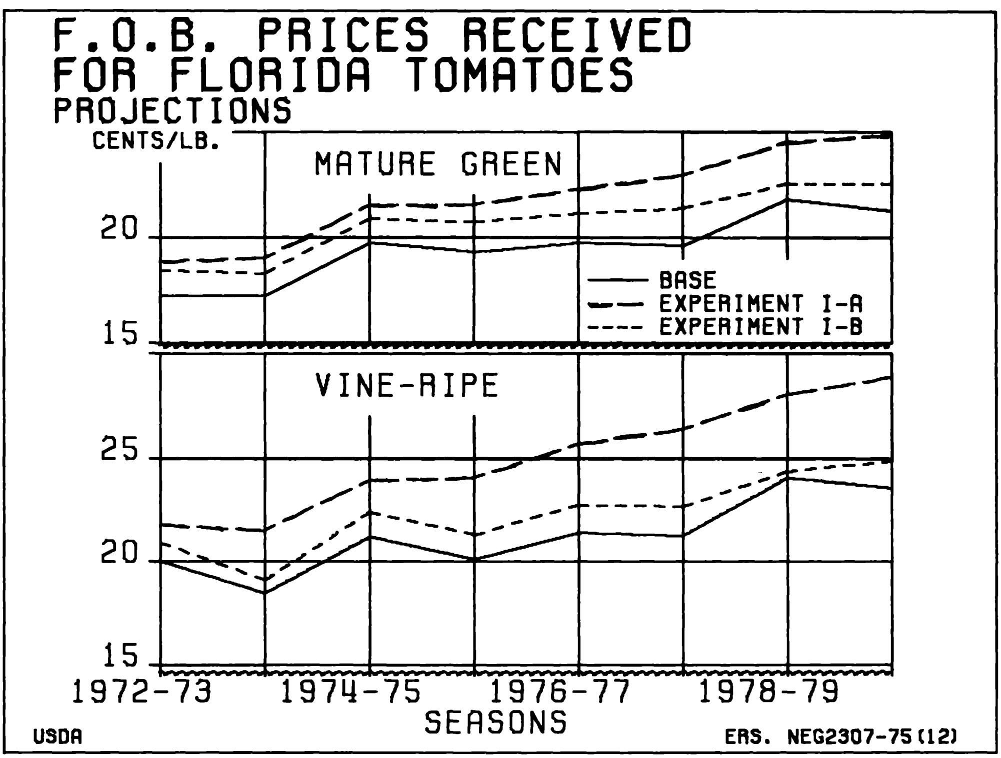

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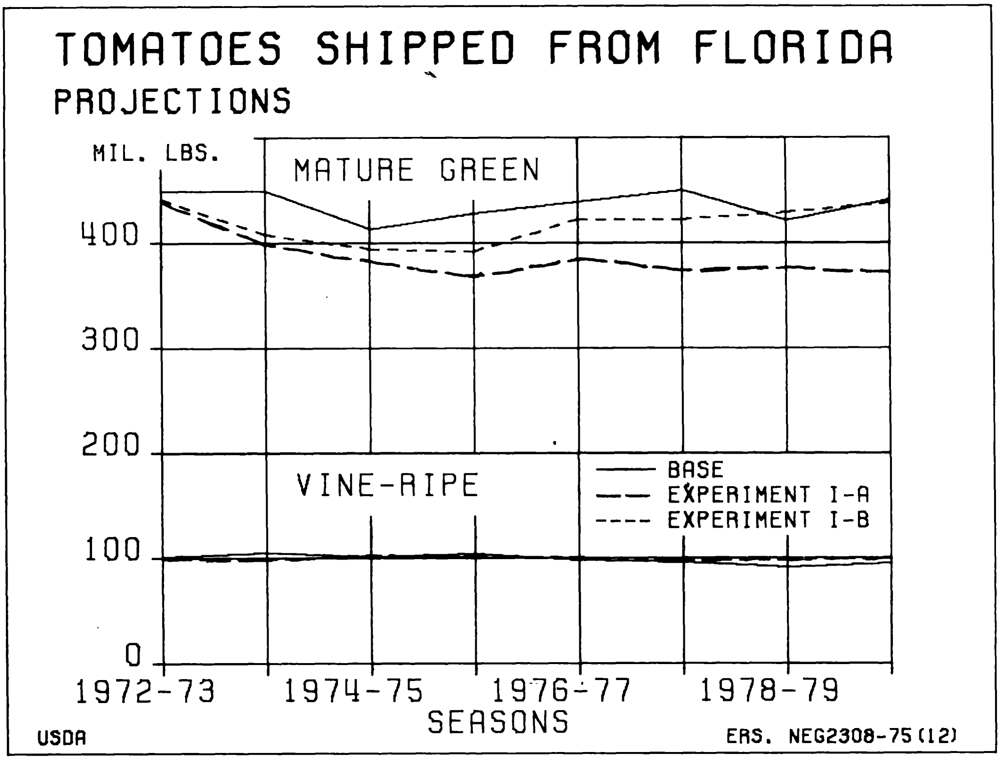

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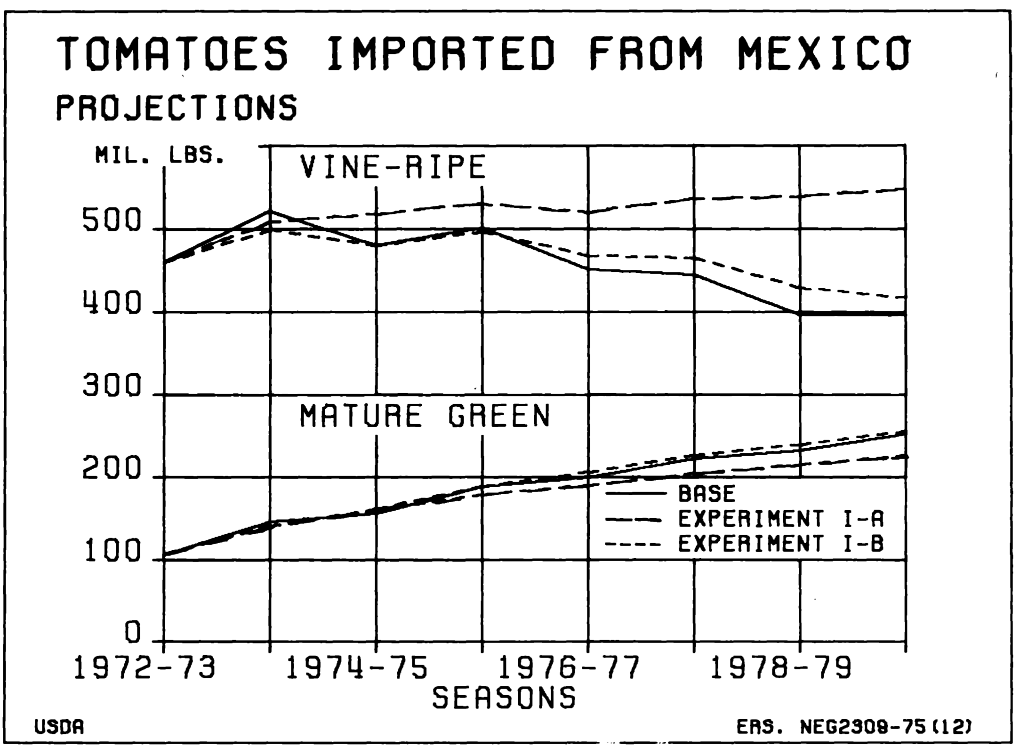

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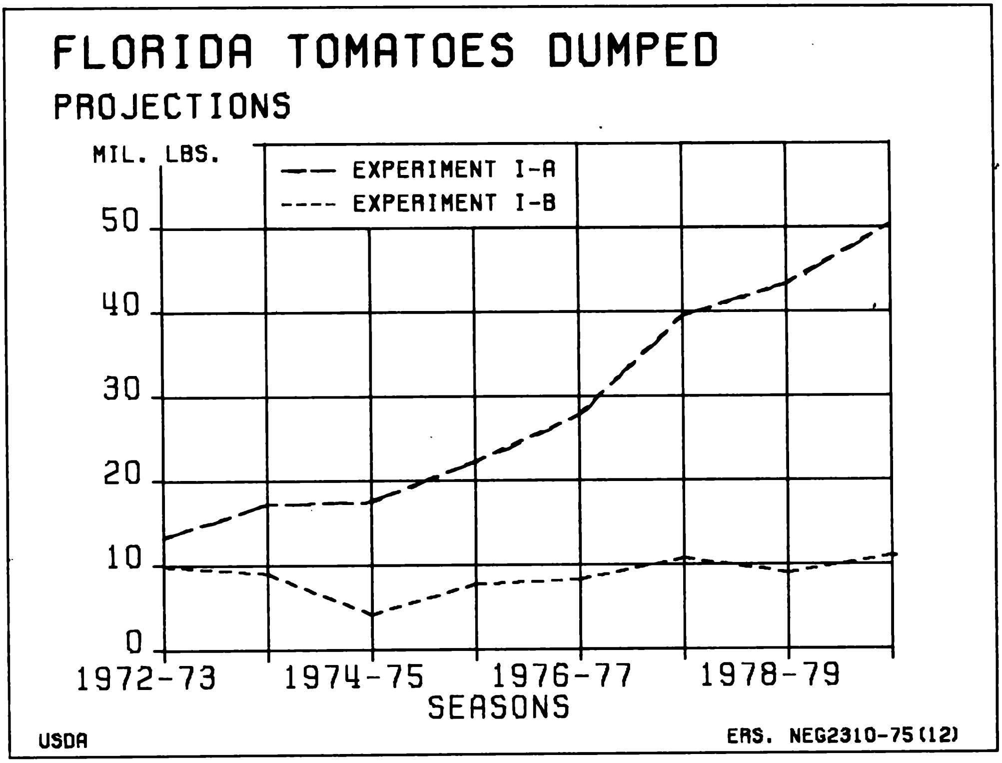

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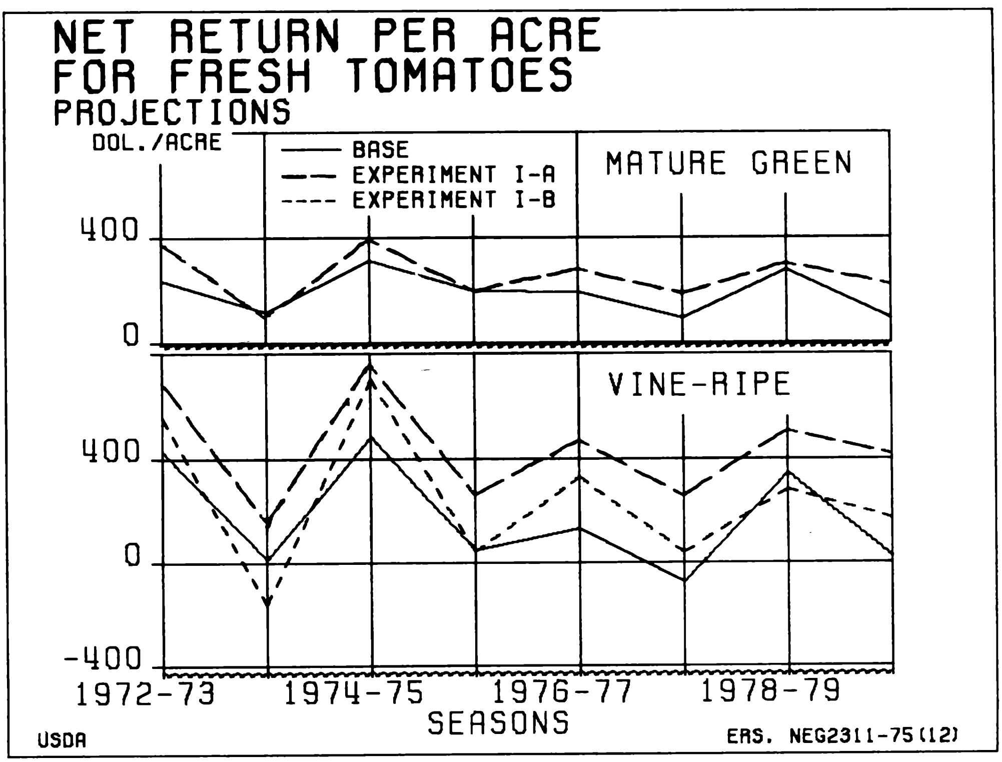

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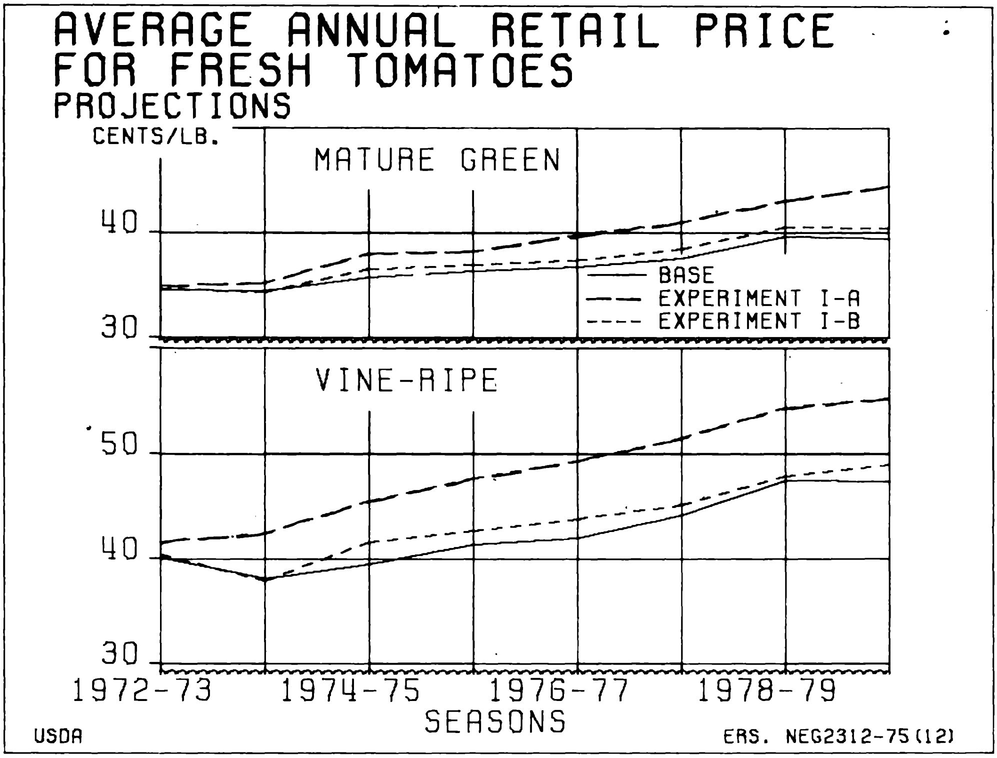

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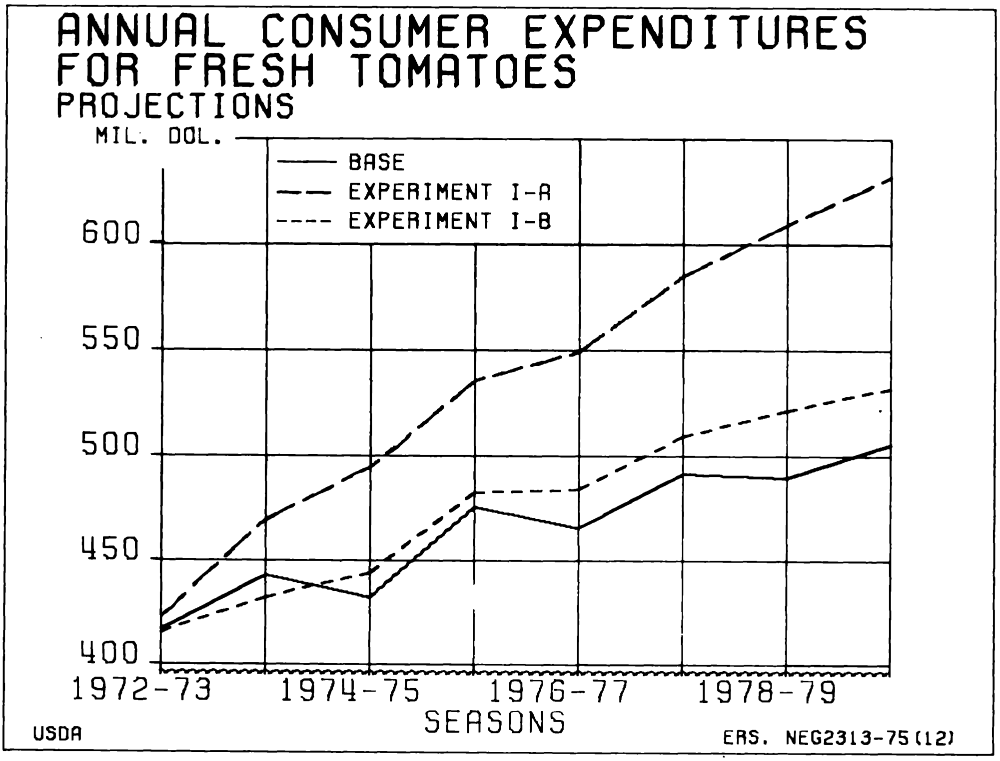

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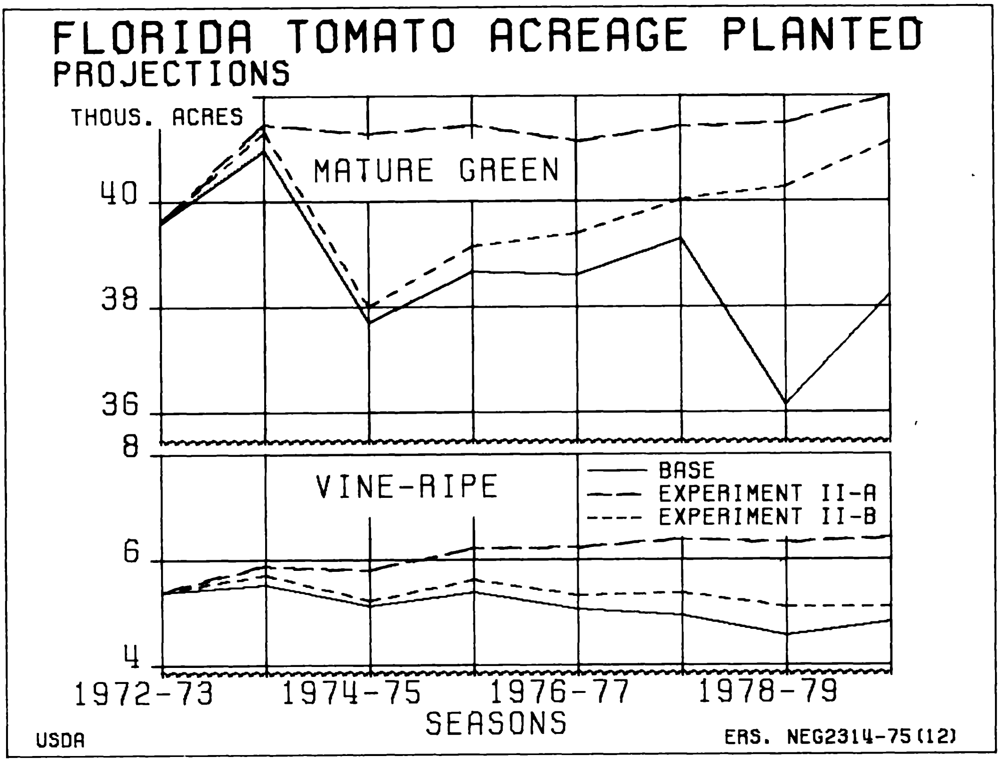

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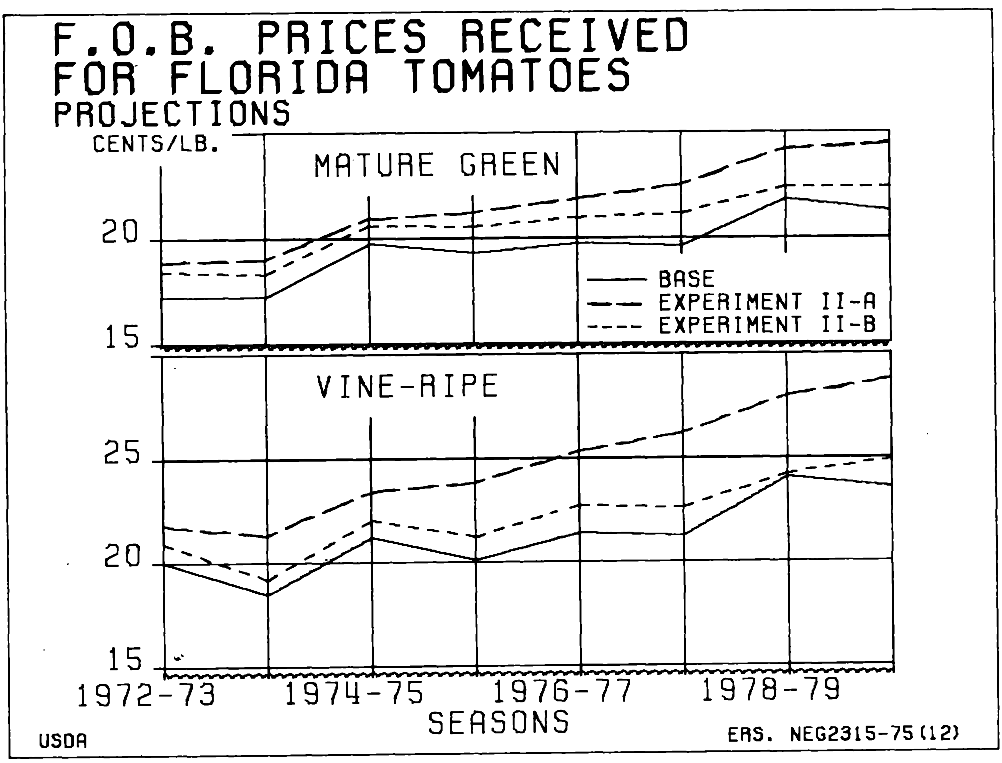

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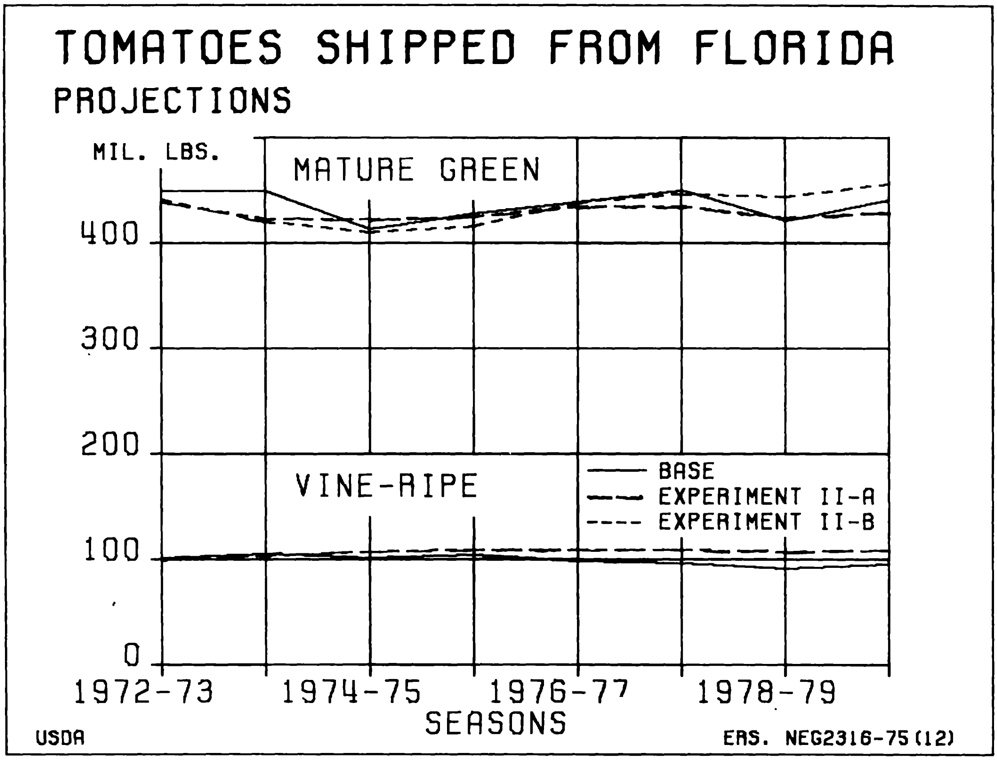

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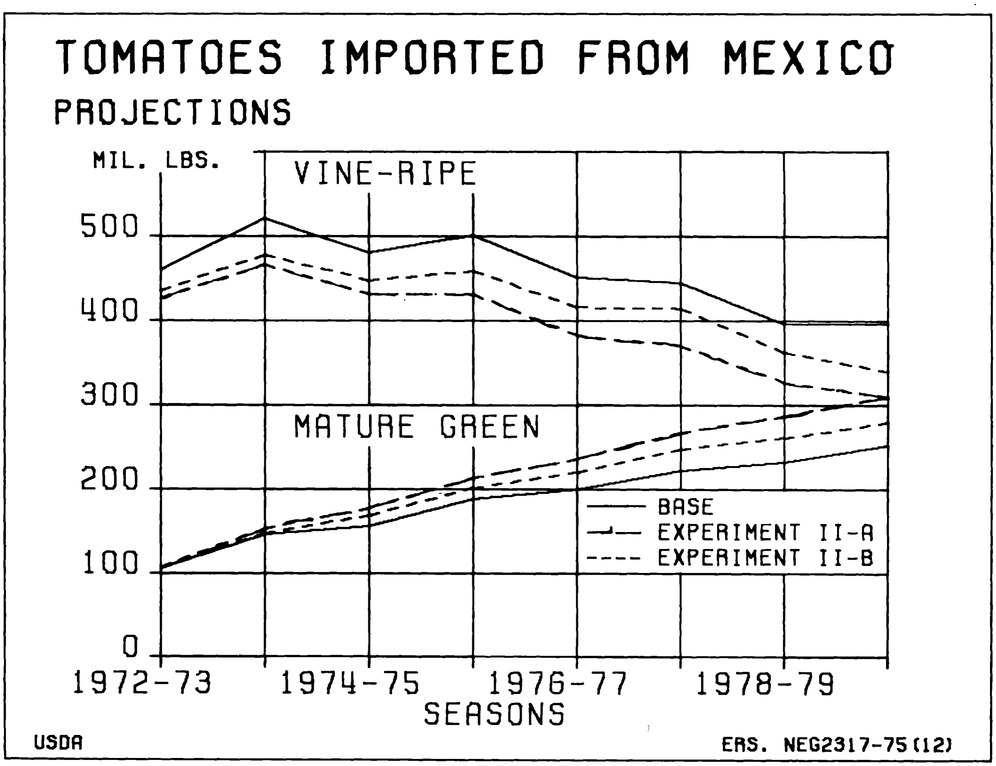

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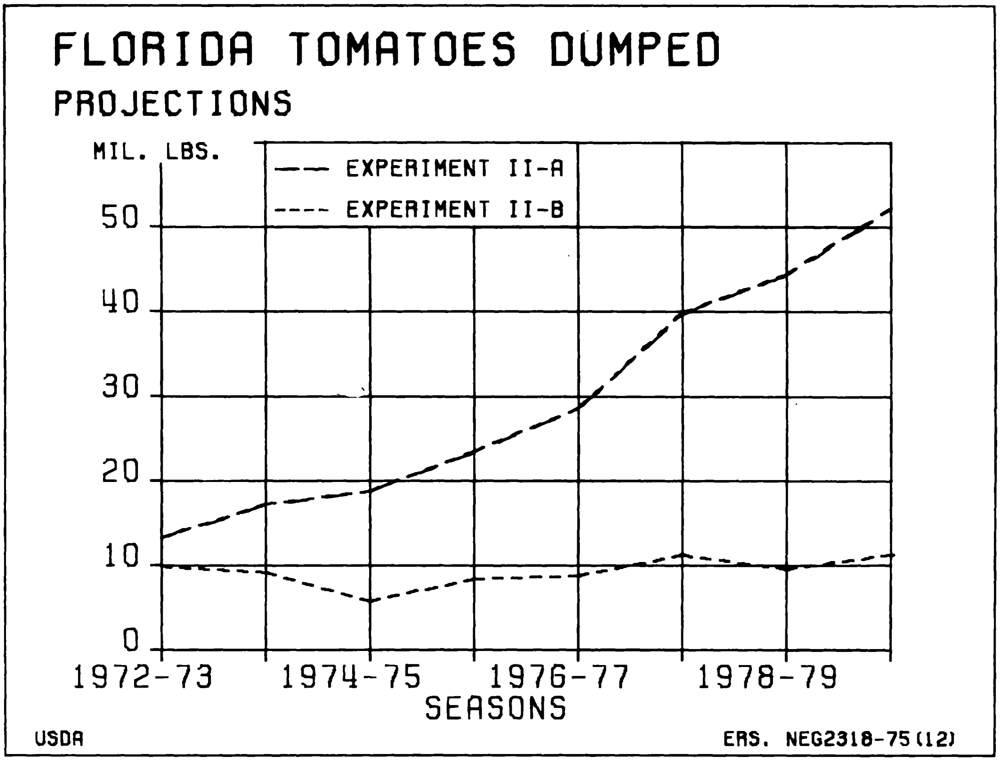

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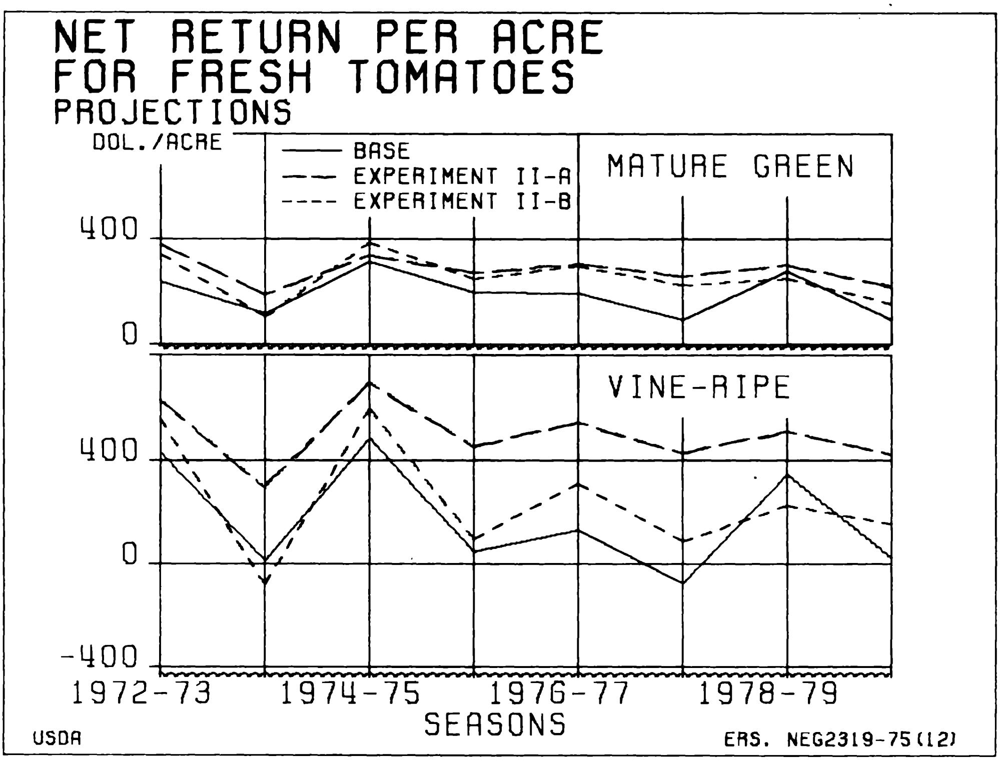

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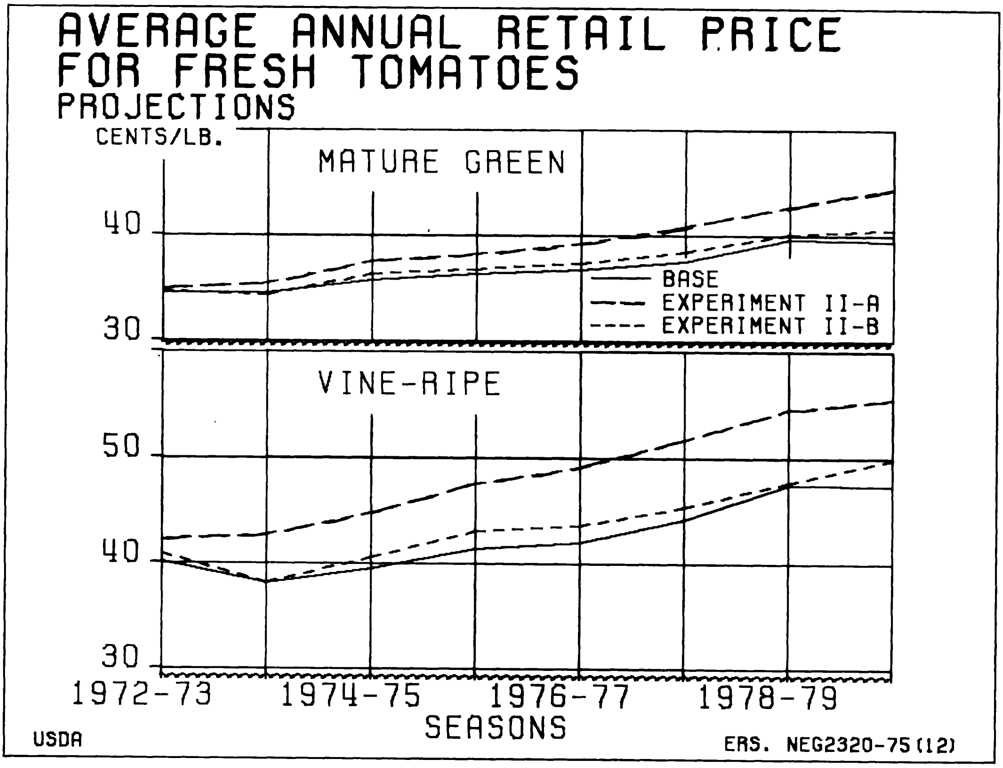

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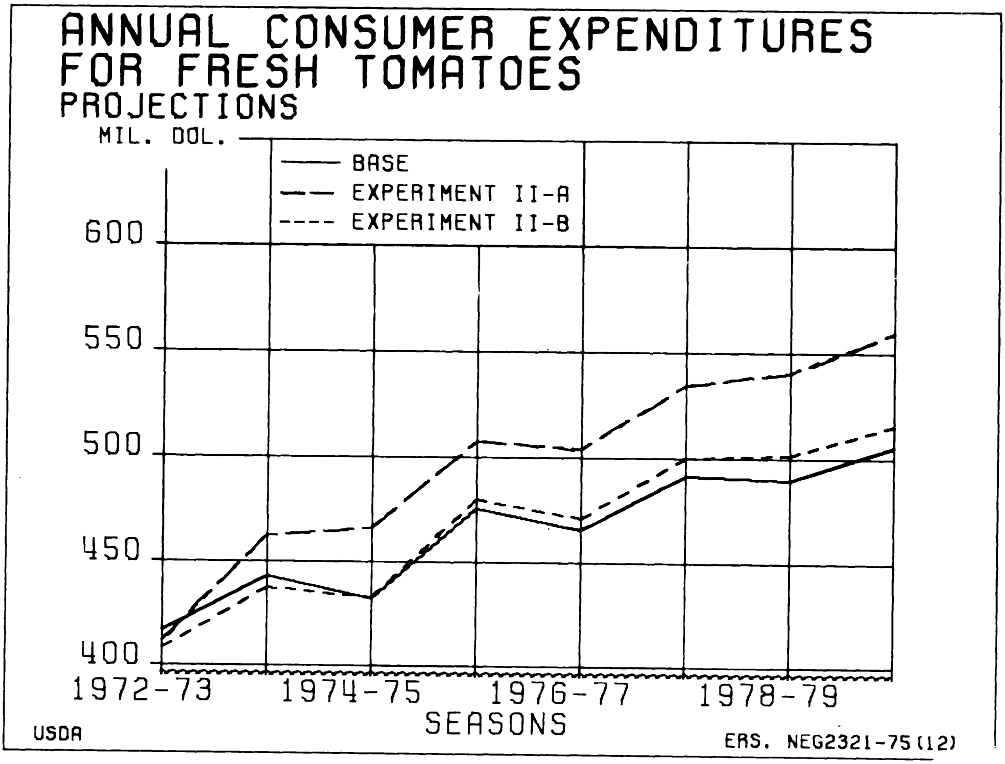

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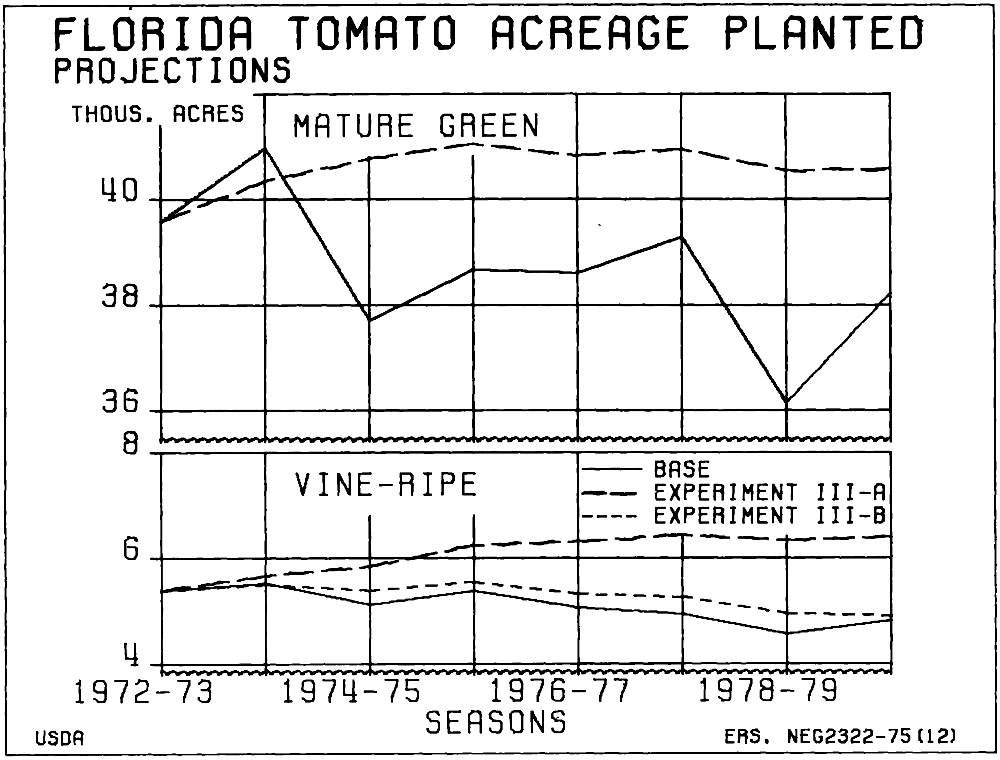

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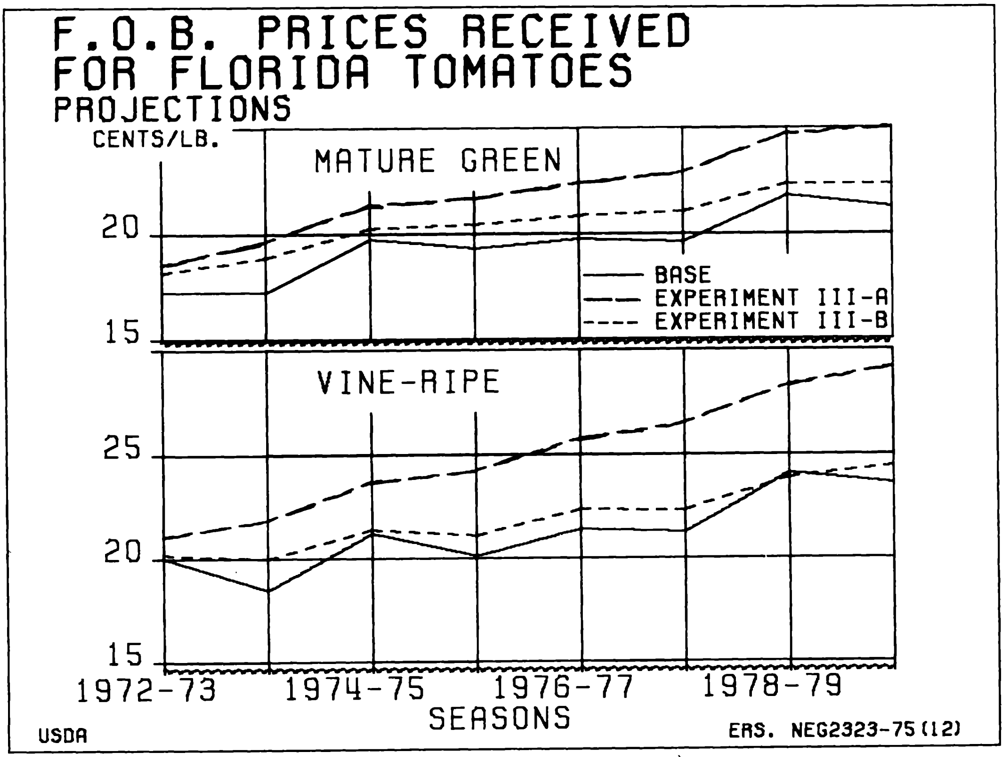

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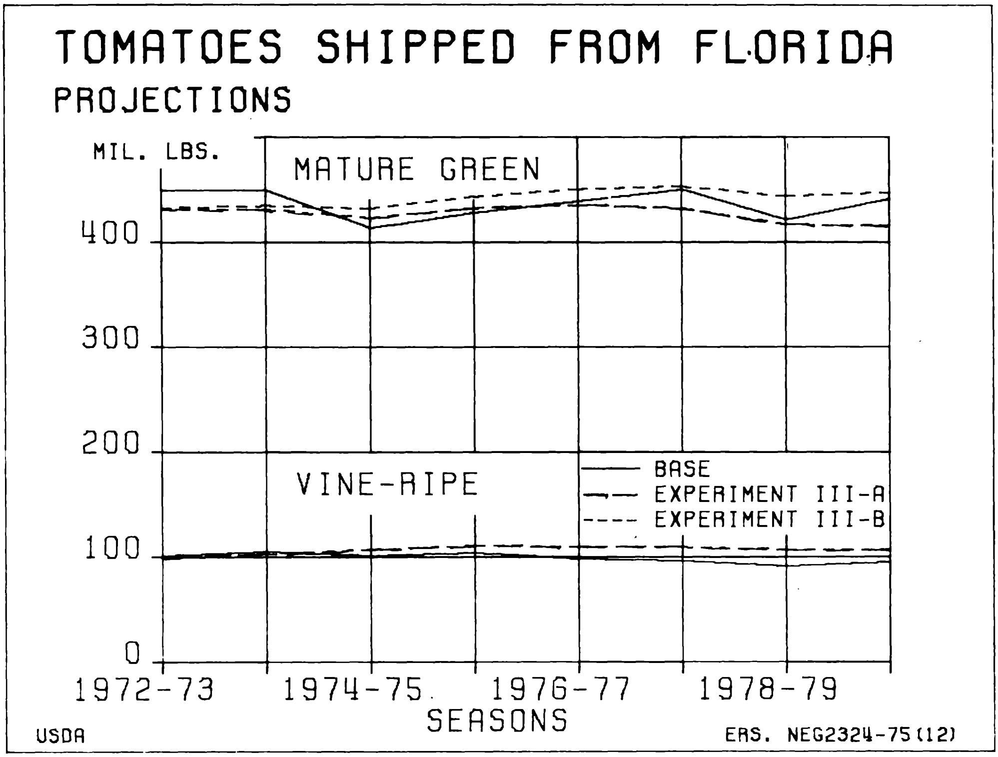

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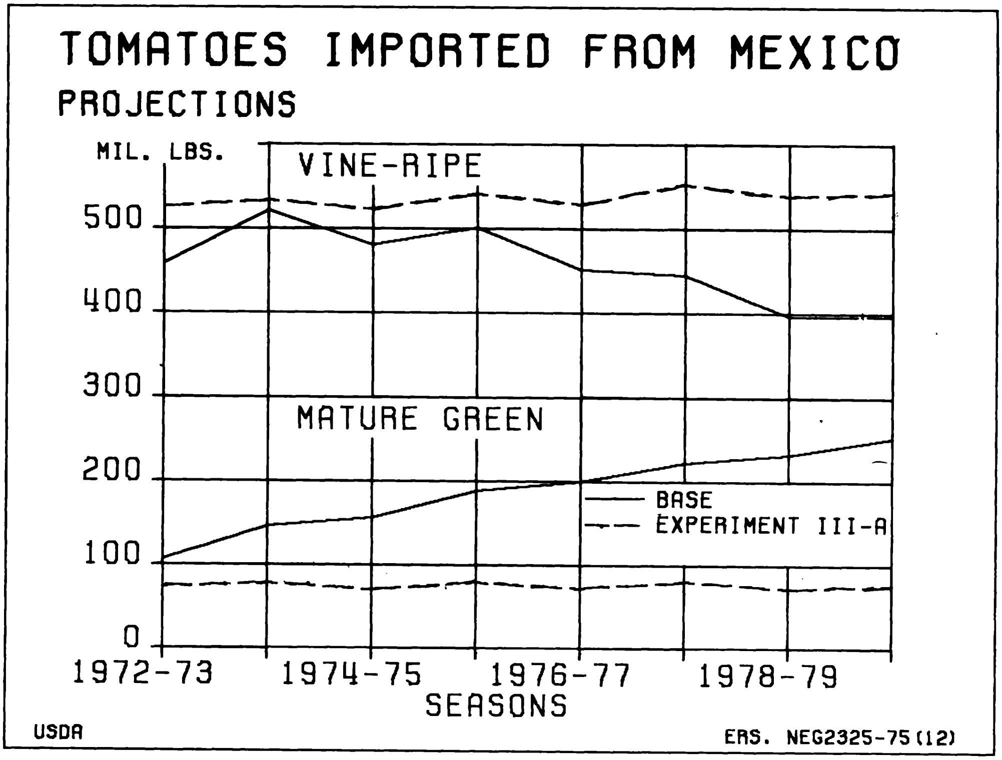

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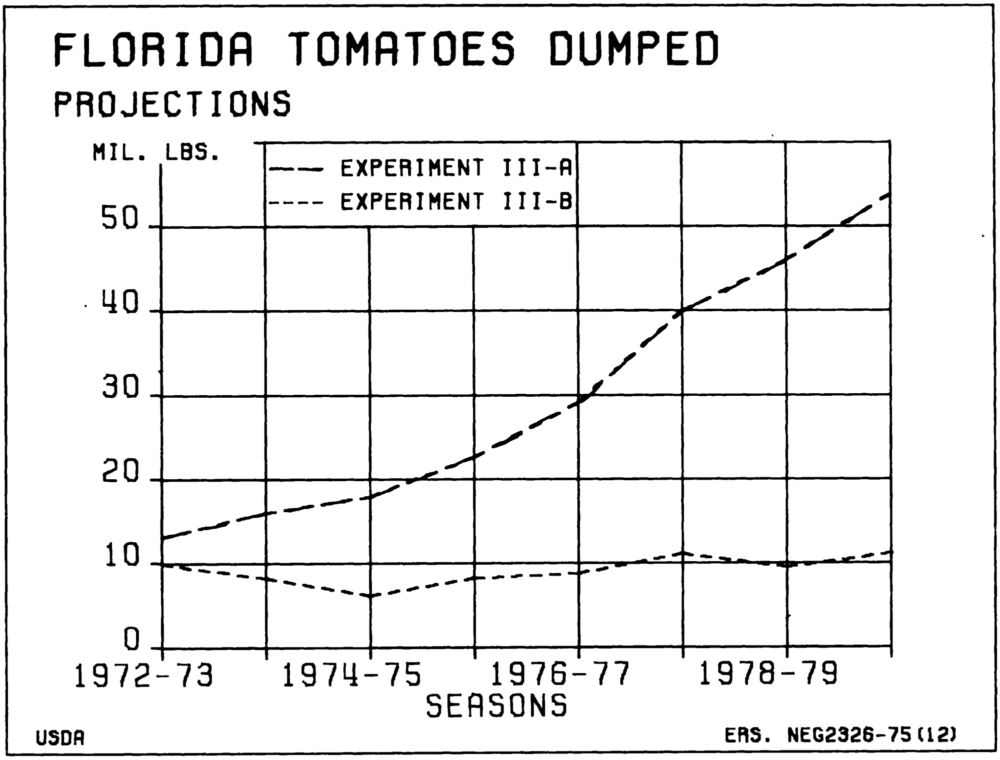

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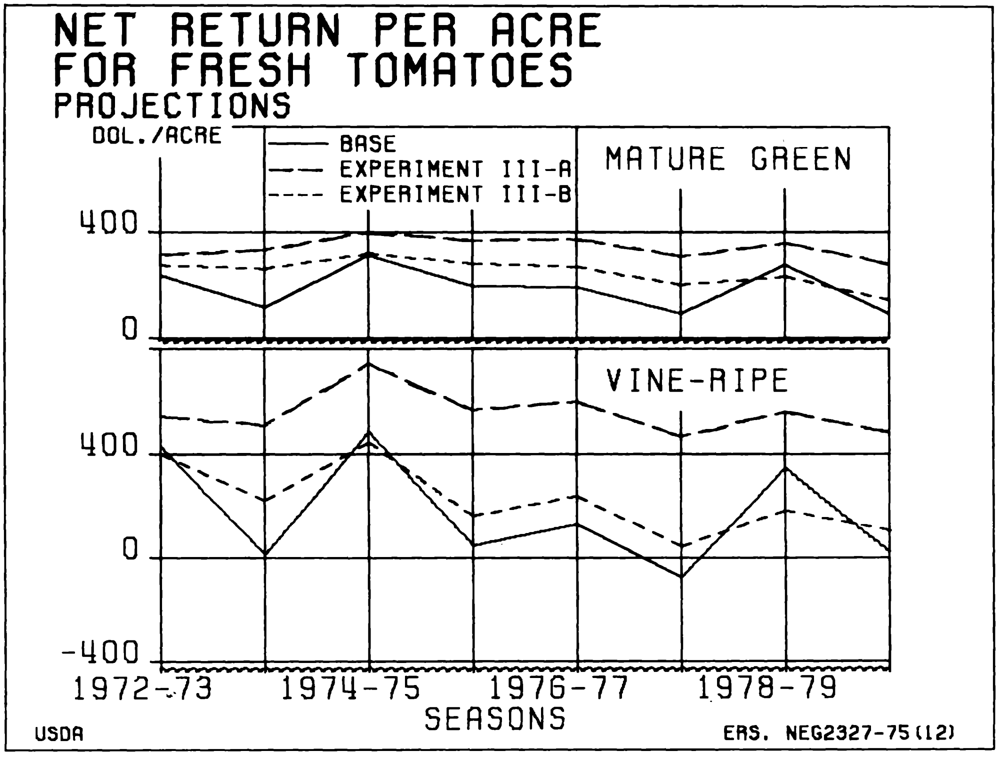

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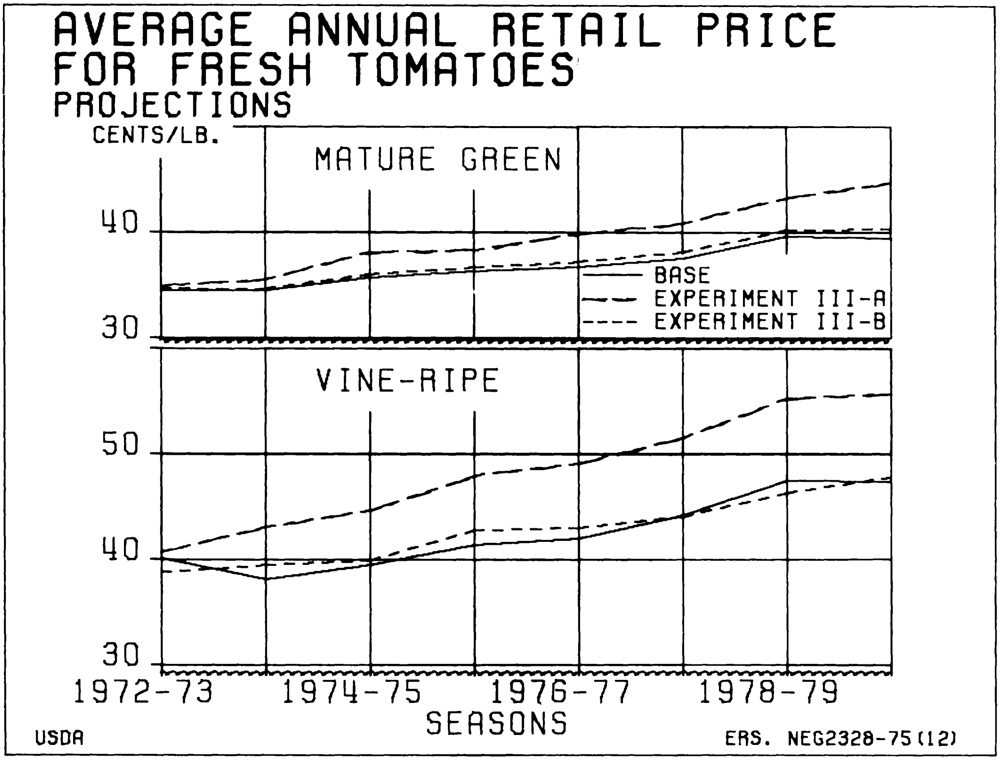

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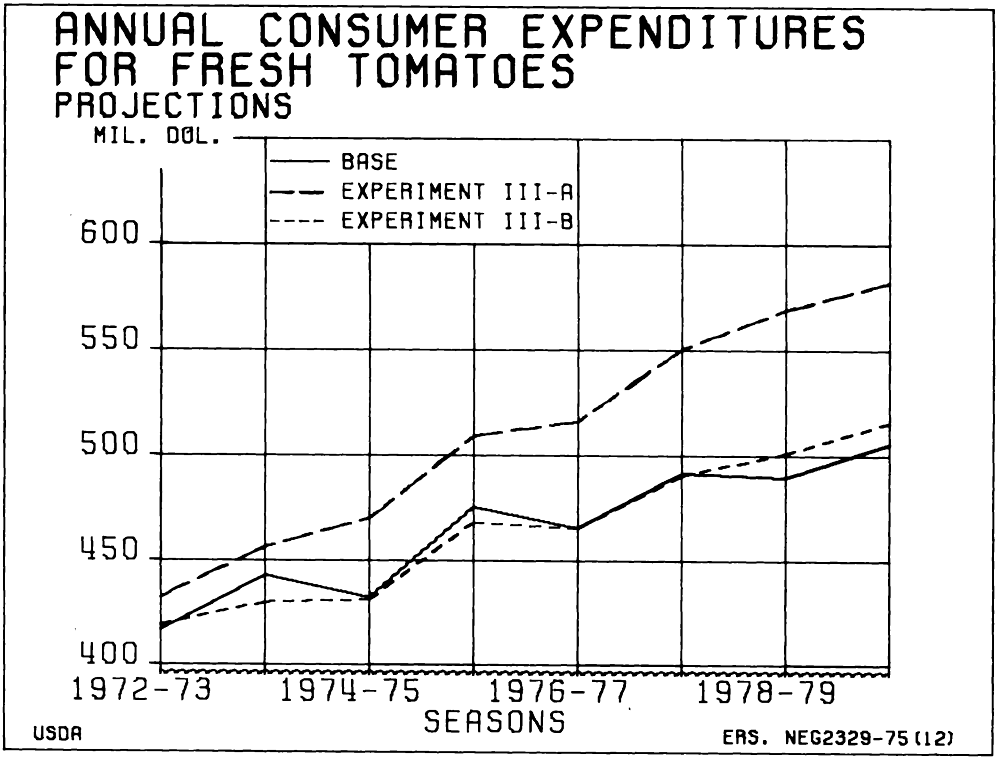

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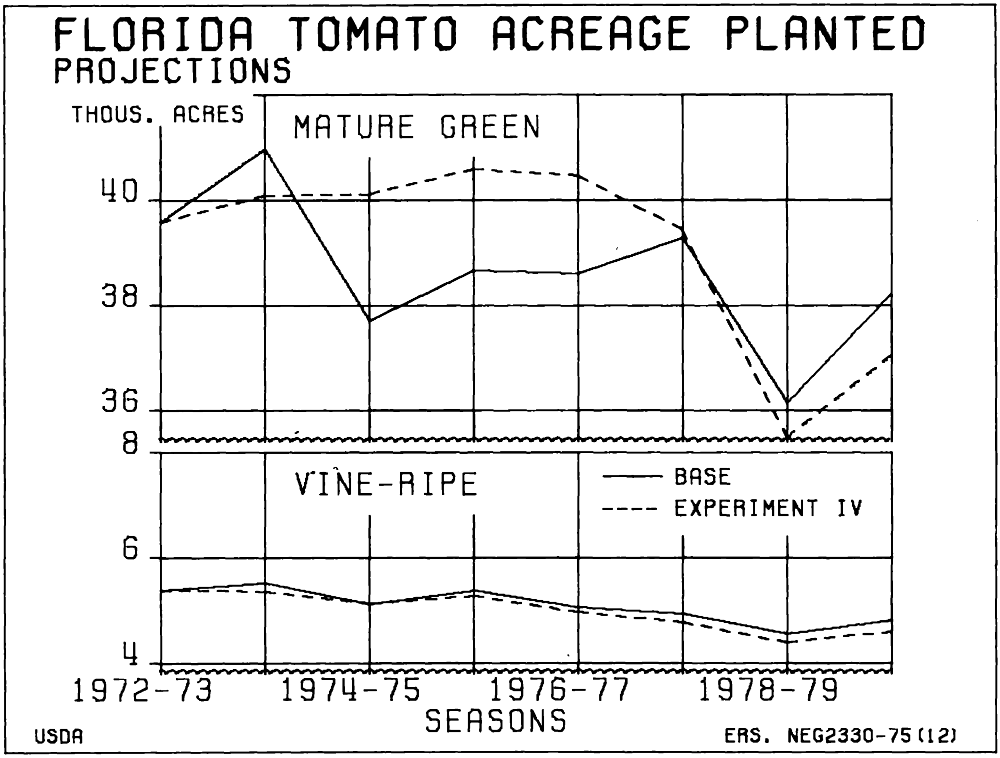

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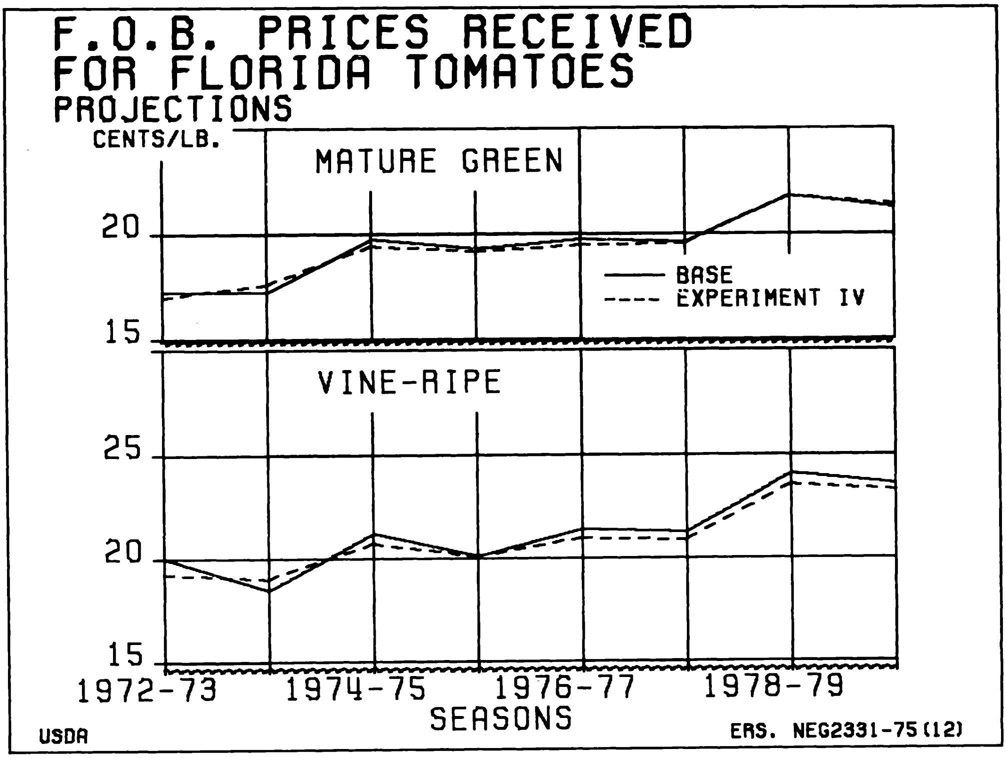

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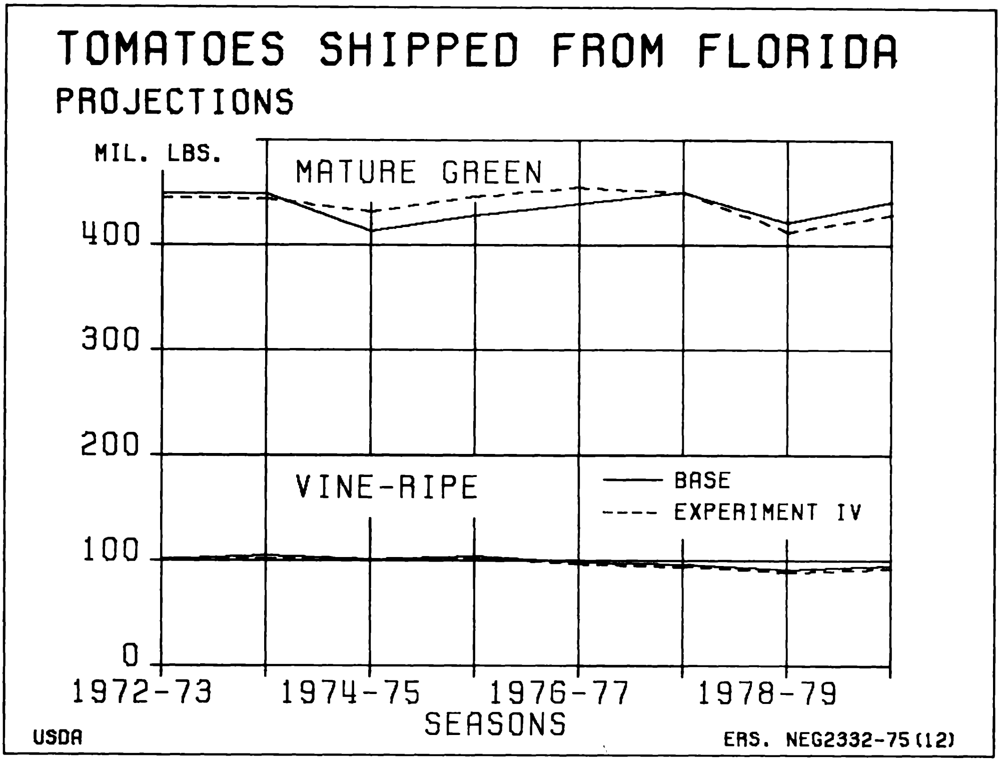

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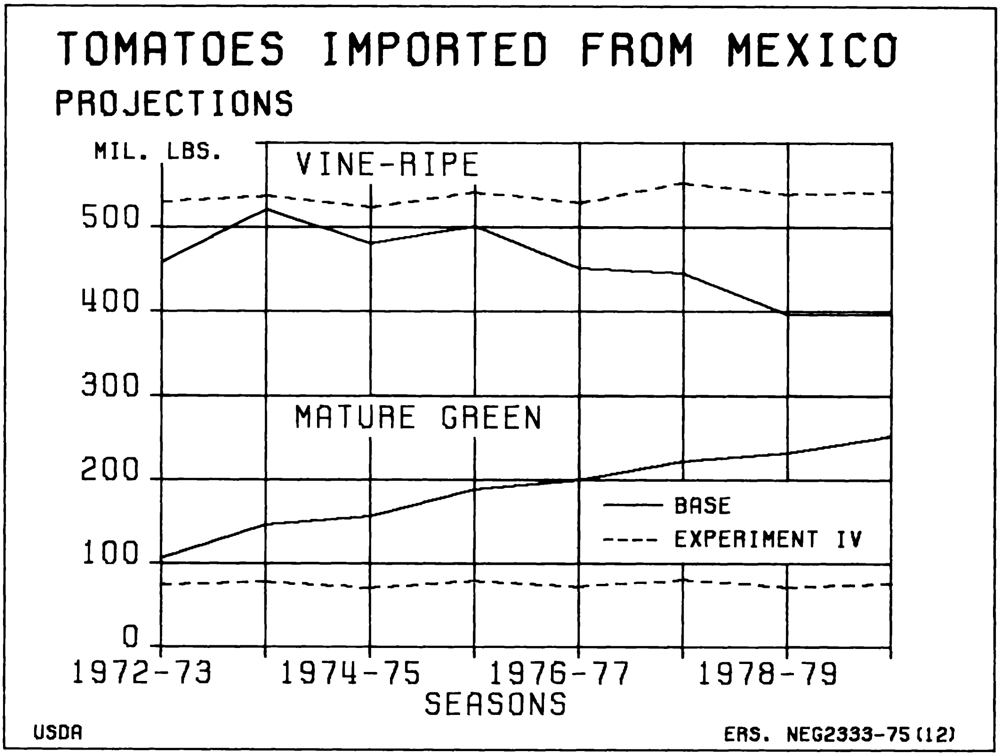

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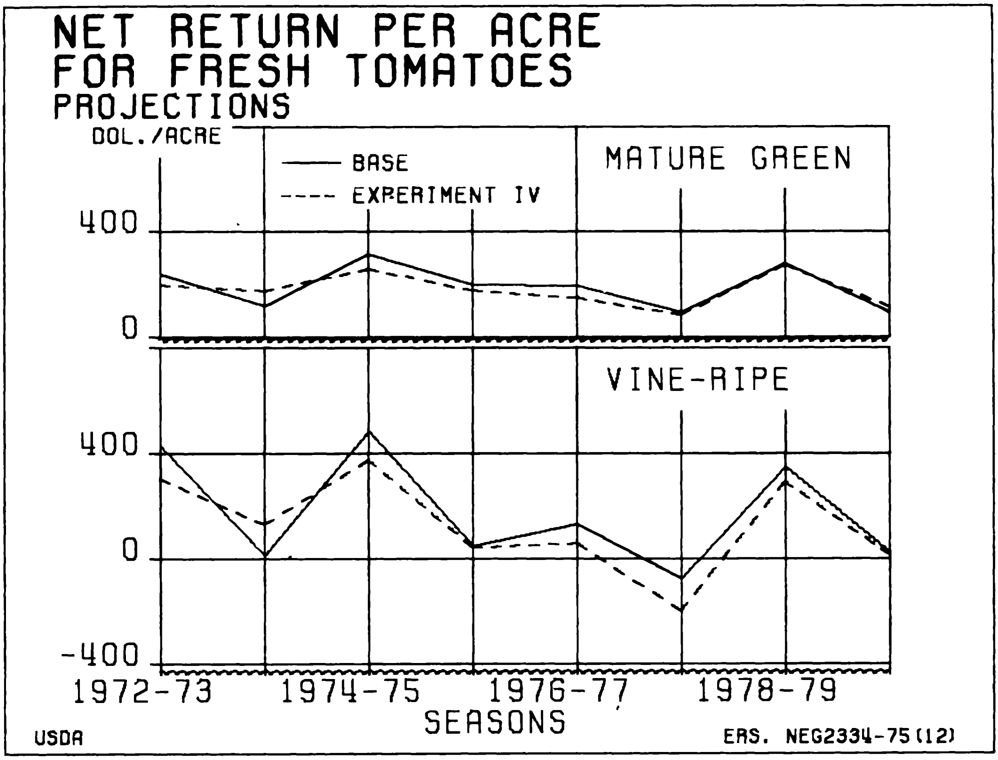

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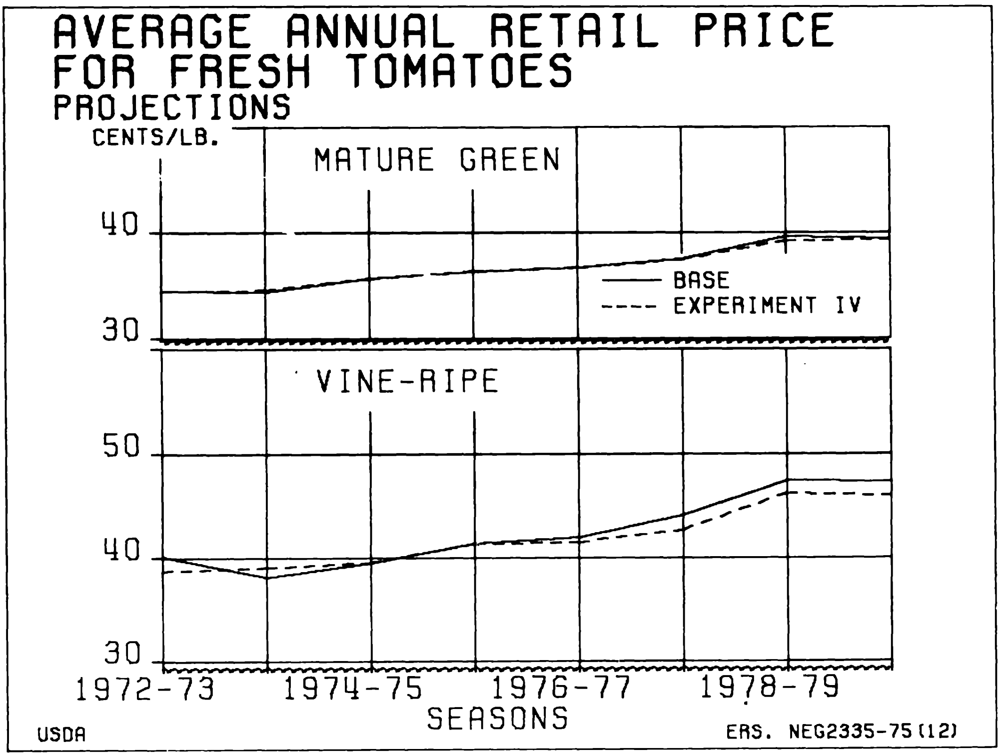

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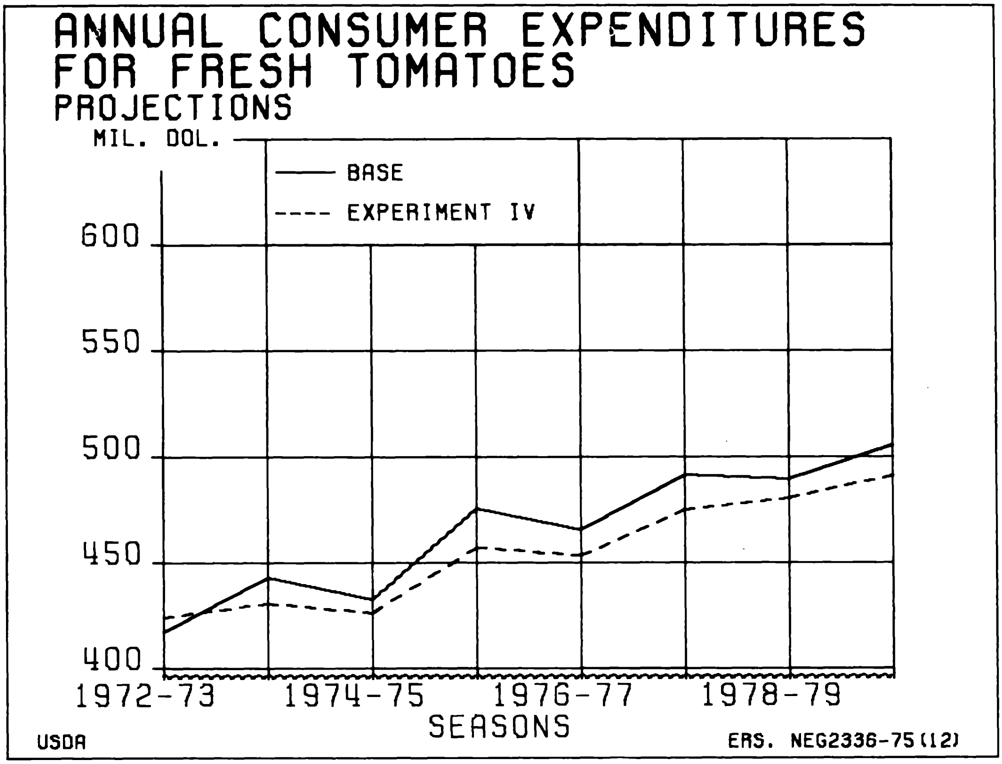

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